EARLY EXERCISE OF EMPLOYEE STOCK OPTIONS: THEORY AND EVIDENCE

By

MARK CLIFFORD ANDERSON

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1996

ACKNOWLEDGEMENTS

I wish to thank the members of my dissertation committee, Professors Rashad Abdel-khalik (chair), Anwer Ahmed, Bipin Ajinkya, and Mike Ryngaert. They have provided me with valuable guidance on numerous occasions.

I appreciate the financial assistance provided by the Fisher School of Accounting at the University of Florida, the American Accounting Association, and the Accounting Education Foundation of Alberta.

I am especially grateful for the constant support of my wife Margaret who has endured much during our years of graduate study. Our children, Elizabeth and Jay, have been a great source of happiness to me. I am indebted to my parents for their encouragement and for their example of a life-time of hard work and commitment, and to my brothers who are great friends. Margaret's family has also provided wonderful support.

TABLE OF CONTENTS

page

ACKNOWLEDGEMENTS.. ii

ABSTRACT.. iv

CHAPTERS

1 INTRODUCTION................................ 1

2 LITERATURE REVIEW........................... 9

The Options Valuation Models in Finance..... 9
The Uniqueness of Employee Stock Options.... 20
Review of the Accounting Literature......... 22
Early Exercise of Employee Stock Options.... 27
The FASB Stance............................. 30
Private Information and Early Exercise...... 37

3 DEVELOPMENT OF HYPOTHESES................... 41

Early Exercise to Obtain a Dividend Payment........................ 41
Early Exercise due to Risk Aversion or Liquidity Preference................... 42
Early Exercise and Speculative Trading on Information............................ 48

4 EMPIRICAL ESTIMATION OF THE EXERCISE TIMING PARAMETER............................ 55

Sample Selection and Data Collection........ 58
Measuring τ................................ 62
Distribution of τ.......................... 64
A Note on Vesting........................... 66

5 TESTS OF THE INFORMATION HYPOTHESES......... 73

6 IMPLICATIONS AND AVENUES FOR FUTURE RESEARCH....................... 89

REFERENCES.. 98

BIOGRAPHICAL SKETCH....................................... 101

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

EARLY EXERCISE OF EMPLOYEE STOCK OPTIONS: THEORY AND EVIDENCE

By

Mark Clifford Anderson

May, 1996

Chairman: A. Rashad Abdel-khalik
Major Department: Fisher School of Accounting

Since employee stock options are inalienable (cannot be traded), the fair value of employee stock options at the grant date depends on the anticipated exercise policies of the employees. If risk or liquidity preferences cause employees to exercise before market traders would exercise similar options, market valuation methods will overstate the fair value of employee stock options at the grant date.

In this study, the exercise decisions of top managers at a sample of publicly traded companies are investigated. For each exercise decision, an exercise timing parameter is estimated. The parameter equals one at the risk-neutral point, and is less than one if exercise occurs before the risk-neutral point. The observed mean value of the exercise timing parameter is slightly lower than one.

Managers' exercise decisions may be influenced by their private information about the firm. Exercise decisions that occur when the exercise timing parameter is very small may be due to trading on negative private information. I test this hypothesis by examining stock price movements subsequent to the exercise date. I find that subsequent stock price changes are significantly lower when the value of the exercise timing parameter is very small.

When the sample is restricted to firms that have non-negative stock price changes after exercise, I find that the mean value of the exercise timing parameter is no longer significantly lower than the risk-neutral value of the parameter.

CHAPTER 1
INTRODUCTION

Measurement of the value of non-cash incentive compensation is important to internal and external decision makers. Internal managers, seeking to maximize firm value, want to offer employees a compensation plan that produces an optimal exchange of effort for pay. External investors want the firm to make compensation contracts that enable the firm to obtain and retain high quality managers in a competitive labor market. At the same time, investors want to monitor the cost of top management compensation.

Stock option compensation has become a very popular form of long-term incentive compensation. In *Fortune* magazine's 1993 survey of CEO compensation, stock options and long-term incentive pay accounted for an average of 51% of the estimated value of the CEO's pay package. Foster III, Koogler, and Vickrey (1991) estimate that recognition of the cost of stock option compensation would have a material income effect for about 30% of non-dividend paying firms and 8% of dividend paying firms. Estimating the fair value of option compensation is important for both managerial control and financial reporting purposes.

The Securities and Exchange Commission (SEC) presently requires publicly traded companies to report (in proxy statements) an estimate of the fair value of option compensation paid to top executives. The Financial Accounting Standards Board (FASB) will require footnote disclosure of the fair value of option compensation in financial statements beginning in 1996. Both the SEC and FASB recommend the use of the Black-Scholes (1973) option pricing model for measuring the fair value of employee stock options at the grant date.

A matter of concern among accountants and business decision makers is whether the Black-Scholes model is appropriate for measuring the fair value of employee stock options. The Black-Scholes model was designed to measure the value of European call options on non-dividend paying stocks. Employee stock options are American, not European options. An American option may be exercised at any time whereas a European option may only be exercised at the termination date of the option.[1]

Finance researchers have investigated the applicability of the Black-Scholes formula to American options that are publicly traded. Merton (1973) showed that the optimal exercise policy for a traded stock option (TSO) on a non-dividend paying stock is to wait until the end of the option term and exercise if the stock price exceeds the market price.

---

[1] Employee stock options are exercisable after they vest.

Since this policy is identical to the only available exercise policy for a European option, the distinction between European and American is not important for measuring the value of TSOs on non-dividend paying stocks. With regard to TSOs on dividend paying stocks, Merton provided an adjustment to the Black-Scholes formula for dividends expected during the option term. With Merton's adjustment, the Black-Scholes formula produces a reasonably close approximation of the value of a TSO on a dividend paying stock.

To evaluate the applicability of the Black-Scholes model to employee stock options (ESOs), the characteristics of the model and the unique position of employees holding ESOs must be considered. The Black-Scholes model assumes that the holder of an option can construct a perfect hedge portfolio by taking a position in the underlying security that offsets the stock price risk associated with the option. A market trader can easily construct a hedge portfolio for a TSO. An employee, however, is usually constrained from building a hedge portfolio around an ESO. If employees could hedge their option positions, the incentive value of ESOs would be lost.

The inability of employees to hedge their option positions affects the employees' personal valuations of ESOs because ESOs are inalienable (employees cannot sell their ESOs to a third party). If ESOs were alienable, risk-averse employees could simply sell their option rights to market traders who would place a higher value on the options.

Inalienability makes ESOs less valuable than similar TSOs from the perspective of the employees (Lambert, Larcker and Verrecchia 1991).

For financial reporting purposes, valuation of employee stock options is done from the perspective of the firm, not the perspective of the employees. The firm may be classified as risk-neutral with respect to ESOs because investors in the firm can hedge their positions.[2] This would appear to make risk-neutral valuation of ESOs appropriate from the perspective of the firm. But since ESOs are inalienable, valuation of ESOs from the firm's perspective must consider the anticipated exercise behavior of the employees.

Huddart (1994) studies the effects of risk-averse exercise behavior on the fair value of ESOs (from the perspective of the firm). The fair value of an option is highest when risk-neutral exercise behavior is anticipated. If risk-averse exercise behavior is anticipated when options are issued, the fair value is less than it would be if risk-neutral exercise behavior were anticipated. Since the fair value is the amount of compensation expense that would be recognized under the new FASB rules, the compensation expense is reduced if risk-averse exercise behavior is anticipated.

Huddart illustrates this with reference to ESOs on non-dividend paying stocks. The optimal risk-neutral exercise policy for options on non-dividend paying stocks is to hold the options until the end of the option term and then exercise if the stock price exceeds the exercise price. Huddart shows that employees who adopt a risk-averse exercise policy will exercise ESOs before the end of the option term if the stock price gets sufficiently high.

---

[2]. Stockholders of the firm already have a long position in the underlying stock so they are naturally hedged against their short position in ESOs.

A variety of personal factors may influence employees' exercise decisions. As in Huddart's (1994) analysis, risk aversion may cause employees to exercise before the risk-neutral exercise point. Other liquidity concerns (cash requirements) may entice employees to exercise before the risk-neutral exercise point. Tax considerations may affect the timing of exercise. Since taxes are paid at exercise, employees may delay exercise to obtain tax deferrals. An anticipated increase in tax rates may cause employees to exercise earlier than they otherwise would.

The timing of exercise decisions may also be influenced by managers' private information. Managers whose private information causes them to believe that the stock is underpriced may hold options longer and managers whose private information causes them to believe that the stock is overpriced may sell earlier than would be predicted by Merton's stock price based exercise rules.

Managers may also be conscious of the signalling effects that their exercise and sell decisions have on the market's interpretation of firm value. Managers may delay exercise of options if they want to signal confidence in their ability tooperate the firm and increase the stock price.

Since numerous factors may affect the timing of exercise, an empirical question of interest is whether or not employees typically exercise before the stock price reaches the risk-neutral exercise point. If risk or liquidity preferences cause members of an employee group to exercise before the risk-neutral exercise point (as determined by Merton's rules), the Black-Scholes model will overstate the fair value of ESOs issued to members of the group (see Huddart 1994).

In this dissertation, I investigate the exercise behavior of top executives at a sample of large companies. Using a model similar to Huddart's variation of the binomial model, I estimate an exercise timing parameter for each exercise decision made by executives in the sample. If the exercise decision is made before the stock price hits the risk-neutral exercise point, the value of the exercise timing parameter is less than one. If the exercise decision is made after the stock price hits the risk-neutral exercise point, the value of the exercise timing parameter is greater than one.

I perform three empirical analyses using the observed values of the exercise timing parameter. I begin by testing the hypothesis that the mean value of the exercise timing parameter is less than one. A value of less than one indicates that managers typically exercise before the stock price reaches the risk-neutral exercise point.

Next, I consider the potential influence of managers' private information on exercise decisions. Exercise decisions that are made long before the stock price reaches the risk-neutral exercise point may be the result of trading on private information. To investigate this, I group exercise decisions according to the level of the exercise timing parameter. Exercise decisions that are made long before the stock price reaches the risk-neutral exercise point have a very low exercise timing parameter. I test whether exercise decisions with a very low exercise timing parameter are more often followed by negative stock price movements than other exercise decisions. I also test whether stock price changes subsequent to exercise are lower for the very early exercise group.

Finally, I restrict the sample to firms that have non-negative stock price performance after exercise. The purpose of this restriction is to control for trading on negative information. Managers who possess neutral or positive private information will not exercise for information reasons, although they may exercise for risk or liquidity reasons. For this restricted sample, I test the hypothesis that the mean level of the exercise timing parameter is less than one.

The remainder of this dissertation is organized as follows. A review of option pricing literature in finance and accounting literature related to the measurement of ESO value is provided in chapter 2. The empirical hypotheses are developed in chapter 3. The sample is described and the distribution of early exercise parameters around the risk-neutral exercise point is presented in chapter 4. Results from tests of the information hypotheses are presented in chapter 5. The distribution of early exercise parameters for the restricted sample is also presented in chapter 5. Implications of this research for Black-Scholes pricing of ESOs and avenues for future research are discussed in the final chapter.

CHAPTER 2
LITERATURE REVIEW

This literature review is organized into six components. In the first component, the prominent options valuation models in finance are described. In the second component, the uniqueness of employee stock options in relation to traded stock options is discussed. The accounting literature related to measurement of ESO value is reviewed in the third component. The problem of early exercise of employee stock options in the context of measuring their fair value is the subject of the fourth component. In the fifth component, the stance of the Financial Accounting Standards Board for measuring the fair value of employee stock options is articulated. Finally, the potential effect of private information on the exercise policy of employees is considered.

The Options Valuation Models in Finance

An understanding of the assumptions underlying the option valuation models is essential to an appreciation of the applicability of the models to estimation of the fair value of employee stock options. Two models will be given extensive treatment in this review, the Black-Scholes (1973) model and the binomial pricing model of Cox, Ross and Rubinstein (1979).

These models are selected because of their prominence in the finance literature, their general popularity as tools for financial analysis, and their selection by the Financial Accounting Standards Board as the models recommended in its standard on stock-based compensation (FASB 1995).

The Black-Scholes model is derived specifically for European options on stocks that do not pay dividends during the option term. A European option may only be exercised on the final day of the option term. In contrast, an American option may be exercised at any time during the option term.

Let c represent the value of a European call option, S represent the current market price of the underlying stock, X represent the exercise price of the option, t represent the time to maturity of the option, r represent the risk-free interest rate, and μ and σ represent the expected stock return and the expected stock return volatility during the option term. The Black-Scholes value of a European option is:

$$c = SN(d_1) - Xe^{-rt}N(d_2)$$

where

$$d_1 = (ln(S/X) + (r + \sigma^2/2)t) \ / \ \sigma t^{1/2}$$

$$d_2 = d_1 - \sigma t$$

and $N(d_i)$ refers to the cumulative normal distribution.

An important observation is that the expected stock return (μ) does not appear in the formula. This result occurs because the Black-Scholes formula is derived under the assumption that the seller of the option can neutralize the risk associated with future stock returns by forming a hedge portfolio that includes the seller's short position in the option and a long position in the underlying stock.[1] The implication of this result is that the Black-Scholes equation is independent of risk preferences.

There are two variables (S and t) and three parameters (X, r, and σ^2) in the Black-Scholes formula. Of the parameters, X is known with certainty and r can be reasonably estimated for the term of the option by referring to the yield on government securities. The third parameter (σ^2) is the expected stock return volatility for the term of the option. It is not observable and must be estimated for each stock.

A weakness of the Black-Scholes model is that the expected σ^2 is stationary throughout the option term. The Black-Scholes model assumes that stock returns follow Markov processes where the mean and variance of returns are stationary over time. However, finance researchers have found that returns to common stock are heteroskedastic. Blattberg and Gonedes (1974) showed that a process in which the variance of stock returns changes randomly through time fits the data better than a constant variance process. Black (1976) observed that the variance of returns varies inversely with the stock price.

---

[1] The buyer of the option may also form a hedge portfolio.

MacBeth and Merville (1980) compared the Black-Scholes estimates of option prices with estimates made using the Cox constant elasticity of variance (CEV) diffusion model (see Cox and Ross 1976). They found that the Cox model predicted market prices more accurately than the Black and Scholes model for in the money and out of the money options.

Since the variance of stock returns is not stationary, estimation of the expected σ^2 is problematic. Two approaches are commonly used. The first is to measure the observed variance of a historic series of stock returns, the second is to implicitly measure σ^2 from observed call option prices. When historical stock returns are used to estimate σ^2, there is a conflict between using a longer history of data to increase the statistical power of the estimate or using a shorter history to get a more recent measure of volatility.

If the market price of an option is known, an implied measure of the expected σ^2 for the term of the option may be obtained. The Black-Scholes formula cannot be solved directly for σ^2 but an iterative technique may be used to solve for σ^2 when the market price of the option is known. This provides a forward looking estimate of σ^2 based on market expectations at the date of measurement.

MacBeth and Merville (1979) showed that this implied measure of volatility is sensitive to the difference between the exercise price and the stock price at the measurement date. Similarly, Beckers (1981) found that the market price of an at the money option is much more sensitive to volatility than the price of an option that is deeply in or out of the money.[2] The conclusion that may be drawn from these studies is that only near the money options should be used to implicitly measure σ^2.

Merton (1973) made many important observations about option pricing and the use of the Black-Scholes model. Merton showed that the optimal exercise point for a traded American option on a stock that does not pay dividends during the option term is at the end of the option term. This is important because it means that the value of a traded American option on a non-dividend paying stock is equal to the value of a European option on a non-dividend paying stock. Therefore, the Black-Scholes model may be extended to American options on non-dividend paying stocks.

Merton's result may be easily explained. The question of interest is whether or not a market trader should hold an in the money American call option. Consider first a portfolio made up of a European call option (with value c) and a risk-free bond with a maturity value equal to the exercise price X. The value of the portfolio may be represented by $c + Xe^{-rt}$. Compare this portfolio to a second portfolio consisting of a share of the underlying stock (with value S). The first portfolio may always be exchanged for a share of the stock on the maturity date. Therefore, if the stock pays no dividends during the option period, $c + Xe^{-rt}$ must be greater than or equal to S. The value of the first portfolio is in fact strictly greater than the value of the second portfolio because the option holder does not need to exercise if the stock price is below X on the maturity date. Thus, $c + Xe^{-rt} > S$ or equivalently $c > S - Xe^{-rt}$. The value $S - Xe^{-rt}$ is Merton's lower bound or the minimum value of a traded option.

---

[2] An option is in the money when the stock price is higher than the exercise price, at the money when the stock price is equal to the exercise price and out of the money when the stock price is lower than the exercise price.

Let the value of an American call option be represented by C. An American option has all of the rights of a European option plus the right to exercise before the end of the option term. Therefore, C must be greater than or equal to c and $C > S - Xe^{-rt}$. Since this inequality holds at any time before the exercise date, it is never optimal for a market trader to exercise a call on a non-dividend paying stock before the expiration date of the option. If the individual holder of the option believes that the stock is overpriced by the market, the holder should sell the option to someone else. Merton's lower bound applies to a traded stock option. Holders of traded stock options are assumed to be able to hedge against stock price risk.

Call option pay-offs are based on stock price movements, not stock returns. Call options do not entitle the holder to receive dividend payments made during the option term. Since stock prices drop on the ex-dividend date by an amount approximately equal to the dividend per share[3], the Black-Scholes formula may be adjusted for dividends expected during the option term. This adjustment to the Black-Scholes formula involves the substitution of S *- (minus) the present value of dividend payments expected during the option term* for S. If the dividend payments are assumed to be riskless, the expected dividends are discounted at the risk-free rate.

This dividend adjustment is appropriate for European options when the timing and amount of dividend payments expected during the option term are known with reasonable certainty. It is not a sufficient adjustment for American options because a declared dividend may be sufficiently large to cause early exercise of the option. Merton observed that a market trader should exercise an American option just before the ex-dividend date if the gain realized by exercising (and obtaining the dividend) is great enough to offset the expected value of continuing to hold the option after the ex-dividend date.

Consider the value of an American option just prior to the final ex-dividend date before the option expires. As before, let S represent the stock price at this time, X the exercise price, t the remaining term of the option, and r the risk-free rate for the remaining term. Also, let D represent the value of the dividend. The ex-dividend value of the stock is approximately equal to $S - D$. Since no other dividend payments are expected, the value of an American call option on the ex-dividend stock must be greater than $S - D - Xe^{-rt}$ (the lower bound of the option value after the ex-dividend date).

---

[3] The stock price change on the ex-dividend date is not necessarily equal to the amount of the dividend per share because of tax considerations.

If the option is exercised just before the stock goes ex-dividend, the amount realized on exercise will be $S - X$. Since the ex-dividend value of an American call option is at least equal to $S - D - Xe^{-rt}$, a market trader will not exercise if $S - D - Xe^{-rt} > S - X$. This expression is equivalent to $D < X - Xe^{-rt}$. The right hand side of this last inequality is the amount of interest that may be saved by not paying the exercise price until the option matures. If D is sufficiently large, it will be optimal for a market trader to exercise the option. The value of the dividend must be somewhat greater than $X - Xe^{-rt}$ for this to happen.

This analysis may be extended to include ex-dividend dates that occur earlier in the option term. The approximate rule that obtains is that a market trader should not exercise an American option if the amount of the periodic dividend is less than the implicit interest earned on the exercise price during the dividend period. For near the money options (i.e. options for which the stock price is close to the exercise price), this approximate rule means that a trader should not exercise if the dividend rate is less than the risk-free rate of interest.

For most stocks, the dividend rate is less than the risk-free rate of interest. Since most short-term traded options are issued at or near the money, the probability of early exercise for dividend reasons is usually small except at the last ex-dividend date during the option term. The probability of early exercise at the last ex-dividend date is larger because the time period between the last ex-dividend date and the end of the option term is usually shorter than a full dividend period (eg. a quarter). In this situation, the value of $X - Xe^{-rt}$ is small because the remaining term t is small.

Black (1975) suggested an approximate procedure for measuring the value of a traded American option using the Black-Scholes formula. His method involves a comparison of the Black-Scholes price (adjusted for expected dividend payments) when exercise is assumed to occur at the last ex-dividend date during the option term with the Black-Scholes price (adjusted for expected dividend payments) when exercise occurs at the end of the option term. The maximum of these two values is used as the value of the option.

MacBeth and Merville (1979) found that the Black procedure makes little difference for measuring the implied volatility of most traded options. Whaley (1982) found a mean pricing error of 1.48% using the Black procedure and a mean error of 2.15% using the adjusted Black-Scholes value without the Black procedure. Whaley's sample included 15,582 options traded on the Chicago Board Option Exchange.

These studies and others indicate that the Black-Scholes method works remarkably well for valuing short-term traded stock options that are near the money. However, potential measurement problems exist when the Black-Scholes method is applied to long-term options. These problems result from possible changes to the volatility during the option term and a much greater probability of early exercise for dividend reasons. The probability of early exercise for dividend reasons is much greater because dividend payments are likely to increase over time whereas the implicit interest on the exercise price remains nearly constant.

The binomial pricing model introduced by Cox, Ross, and Rubinstein (1979) permits more flexibility than the Black-Scholes model with respect to expected changes in σ^2 and early exercise for dividend purposes. In the binomial model, a stock option's life is treated as a series of discrete time periods. In each period the stock price is assumed to follow a binomial process which means that the price either goes up by some discrete amount or down by some discrete amount. The probability and magnitude of the discrete up or down movements are determined by the parameters of the distribution.

The assumptions underlying the binomial model are very similar to the assumptions underlying the Black-Scholes model. In particular, the seller (or buyer) of the option is able to costlessly hedge the option position. Using simple arbitrage arguments, Cox, Ross, and Rubinstein showed that the value of an option is not dependant on the expected return to the stock. Therefore, only the risk-free rate of return and the expected volatility of the stock returns are needed to estimate the binomial value. The information required to numerically estimate the binomial value is the same as the information required to estimate the Black-Scholes value. The binomial model contains the Black-Scholes result as a special limiting case.

In the binomial model, the life of an option is represented by an ingrown tree. At each discrete time interval within the tree, the price of the stock is assumed to move up or down by an amount that is determined by the level of expected stock return volatility σ^2 and the length of the discrete interval. The probability of an upward movement may be represented by p. The probability of a downward movement is $1 - p$. The value of p depends on σ^2, r, and the length of the interval.

The discrete nature of the binomial model gives it more flexibility than the Black-Scholes model. Different estimates of σ^2 may be used during different intervals (estimates of σ^2 may be changed with the level of the stock price or with calendar time). Expected dividend payments occurring at the end of a discrete interval may simply be subtracted from both the "up" stock price and the "down" stock price at the end of the interval.

In addition, an exercise rule may be used to accommodate early exercise of American options. Following Merton's rule, if the gain to be realized by exercising just before the ex-dividend date exceeds the ex-dividend option value, exercise is assumed. The branch of the binomial tree is terminated at this point with the final pay-out equal to the gain realized on exercise.

Both the Black-Scholes model and the binomial model rely on the assumption that holders of options are able to costlessly construct perfect hedge portfolios. In both models this assumption leads to the finding that risk preferences are not relevant for estimating the value of a traded stock option.[4]

The Uniqueness of Employee Stock Options

Employee stock options (ESOs) differ in four important ways from most traded stock options (TSOs). Researchers that recognized some or all of these differences include Weygandt (1977), Noreen and Wolfson (1981), Lambert, Larcker and Verrecchia (1991), and Huddart (1994). The four differences are described below. The implications of these differences for measuring the fair value of employee stock options will be discussed in the remaining parts of this chapter.

---

[4]. This does not mean that the expected return from holding an option is equal to the risk-free rate. The expected return is equivalent to the expected return from holding the hedging portfolio (made up of a leveraged long position in the stock).

(1) ESOs have much longer lives than TSOs. A recent survey found that 87% of ESOs have terms of 10 years or more (Buenaventura and Peck 1993). Most TSOs have terms of less than 180 days. A relatively small number of TSOs have terms of one to three years. The long lives of ESOs make them more susceptible to early exercise for dividend purposes or other reasons and to valuation errors caused by changing parameters, especially σ^2.

(2) ESOs are inalienable. They cannot be sold by the employees to a third party. The employees may settle their option positions through exercise only. TSOs, on the other hand, are exchange traded.

(3) Most employees holding ESOs may not hedge their long position in the options by taking a short position in the underlying stock. Managers' investments in the firm's stock are closely monitored by the firm and by the SEC. The combination of inalienability and the inability to hedge means that employees may not neutralize the risk associated with the underlying stock returns.

(4) Many ESOs have vesting restrictions. Typically, vesting occurs over a three to five year period in equal annual increments. For example, 25% of the options may vest on the first anniversary date of the issue of the options, 25% on the second anniversary date and so forth. Not all options have vesting restrictions and rarely does complete vesting take more than five years. Vesting has two effects on ESO

valuation. First, since there is positive probability that employees will leave the firm before stock options vest, the fair value of ESOs should be adjusted for expected turnover. Second, vesting may restrict employees from exercising as early as they may like. If a firm's stock price rises rapidly during the early years of a stock option's life, the employees may want to exercise before the options have vested.

Review of the Accounting Literature

Accounting researchers have expressed dissatisfaction with accounting for employee stock options for over 35 years. Sweeney (1960) argued that employee stock options are a substitute for cash compensation and that the full cash value of an employee's services should be recorded as compensation expense. He thought that the value of employee stock options should be implicitly measured as the difference between the total value of the employee's services and the cash value of the other remuneration paid to the employee.

Two issues are raised by Sweeney's argument. First, are employee stock options a substitute for cash compensation or are they something else? Second, how can the economic value of an employee's services be measured?

With regard to the second issue, Campbell (1961) took the position that the fair value of employee stock options should be directly measured. He suggested that expected earnings growth could be used to extrapolate an estimate of the future stock price. This estimate could then be multiplied by a risk factor he described as the "degree of certainty" (that the stock price would at least reach the estimated amount) to get an approximation of the value of the options. Campbell's proposal did not meet accountants' requirements of objectivity and verifiability.

Very little progress was made on the measurement issue until the breakthroughs in option pricing made by Black and Scholes (1973) and Merton (1973). Smith and Zimmerman (1976) proposed measurement of ESO value using the lower bound on option prices derived by Merton. Under this method, option value is measured as the difference between the current market price of the stock and the discounted exercise price. For stocks that pay dividends, the option value is further reduced by the present value of foregone dividends. This simple approach has become known as the minimum value method. Use of this method would satisfy the requirements of objectivity and verifiability.

Weygandt (1977) suggested that the Black and Scholes method could be applied to employee stock options. He indicated that further empirical work was needed to validate the use of this method. As discussed previously in this chapter, finance researchers provided empirical validation of the Black-Scholes model for valuing short-term options. But, most employee stock options have terms of 10 years or more.

Noreen and Wolfson (1981) tested the application of the Black Scholes model and the Cox model for a constant elasticity of variance (CEV) diffusion process (see Cox and Ross 1976) to long-term warrants with characteristics similar to ESOs. They collected a sample of traded warrants where the market price of the underlying stock was nearly equal to the exercise price.[5] Their sample included warrants that had remaining terms of 2 to 6 years. They compared the estimated Black-Scholes price and the Cox CEV price with the market price of the warrants. Noreen and Wolfson found little difference between the two model estimates but they found negative mean absolute errors of about 16 to 20 percent when they compared the model estimates to market prices.

With reference to Noreen and Wolfson's work, Galai (1989) observed that most of the negative mean error could be explained by errors committed in applying the models to the actual data. In their work, Noreen and Wolfson made an adjustment to the model estimates of option value for potential dilution of the stock by the exercise of the warrants. Galai indicated that this adjustment was unnecessary because stock prices reflect the potential dilution. The implication is that the model estimates were reasonably accurate.

---

[5]. In their survey, Buenaventura and Peck (1993) find that 97% of employee stock options are issued with an exercise price equal to the market price at the issue date.

Weygandt (1977) and Noreen and Wolfson (1981) expressed concern about potential measurement problems caused by the personal nature of ESOs. Employees must surrender ESOs if they quit the firm before the ESOs vest. In many cases, employees who quit must exercise any vested ESOs when they leave. Jennergren and Naslund (1993) suggested a method for dealing with turnover concerns when measuring the grant date value of ESOs. Their approach involves the use of a partial differential equation (similar to Black-Scholes) that incorporates an additional parameter, the rate at which employees leave their jobs. This approach is more satisfactory for employees at lower levels in the organization than for top executives. Estimation of quit rates for top executives is difficult because of the uniqueness of their positions.[6]

Lambert, Larcker and Verrecchia (1991), LLV hereafter, provided an analysis of the implications of inalienability for measuring the value of ESOs. They recognized that inalienability together with the inability to hedge against stock price movements puts employees at risk. Risk-averse employees should value ESOs less than market traders would value similar instruments.

---

[6]. The FASB has addressed this problem in their standard. The standard offers two solutions. First, the expected number of options that will vest may be used in the determination of ESO cost. Second, an ex post adjustment may be made for forfeiture of options before they vest.

LLV pointed out that the observed popularity of employee stock options is indicative of their role as incentive compensation. Holmström (1979) showed that optimal contracting involves a trade-off between the incentive value of risky compensation and the cost of risk-sharing between a risk-neutral principal and a risk-averse agent. If stockholders are assumed to be risk-neutral (or less risk-averse) with respect to ESOs, then ESO compensation involves costly risk-sharing with employees.

From the perspective of the firm, LLV reasoned that market valuation of ESOs was appropriate since the firm's stockholders are able to actively hedge their option positions. In fact, the stockholders' short position in the options is hedged by their long position in the stock. LLV concluded that market valuation methods, such as the Black-Scholes method, should be acceptable for measuring the fair value of ESOs from the perspective of the firm.

LLV's contribution is important because they provide support for risk-neutral valuation from the perspective of the firm. However, they missed a potentially important aspect of inalienability in their analysis. They did not consider the effect of risk aversion on the exercise policy of employees who cannot sell their options. This issue is treated in the next section where the problem of early exercise is discussed.

Early Exercise of Employee Stock Options

Huddart (1994) addressed the potential effect of employee risk aversion on the fair value of employee stock options. He made a key observation that the exercise policy adopted by employees affects the fair value of ESOs from the perspective of the firm.

Recall that both the Black-Scholes model and the binomial model rely on the assumption that the stock price risk associated with the options may be perfectly hedged. LLV observed that this assumption describes the position of the stockholders but not the position of employees who cannot hedge their positions or sell the options. This combination of risk-neutrality on the short side and risk-aversion on the long side of the options has very interesting implications.

From the perspective of the stockholders (the sellers), risk-neutral valuation is appropriate for determining the fair value of ESOs. However, anticipated risk-averse exercise behavior by employees impacts the valuation from the perspective of the firm. If employees adopt risk-averse exercise policies, they will exercise at a lower stock price than the stock price that corresponds to the risk-neutral exercise point. Since the fair value of an option is maximized with a risk-neutral exercise policy, an exercise policy that deviates from risk-neutral exercise will reduce the fair value of the option.

This means that for estimation of the fair value of an ESO from the stockholders' perspective, the assumption of perfect hedging (necessary for the application of the Black-Scholes or binomial methods) may be maintained but the possibility of early exercise caused by risk-averse behavior must be considered. Since the Black-Scholes method is derived for European options it cannot explicitly accommodate early exercise caused by risk-averse exercise behavior. The binomial model is much more flexible and permits the use of exercise rules. If a risk-averse exercise policy is anticipated, a binomial estimate of the fair value of an ESO can be made that incorporates the anticipated effects of risk-aversion.

When ESOs are issued, the exercise price is generally set equal to the stock price at the issue date. The employees bear little downside risk at this point. However, if the stock price rises, the employees bear downside risk similar to that of the stockholders. Since employees are restricted from constructing hedge portfolios (taking short positions in their firm's stock), the risk associated with stock price movements may only be diversified by holding other securities. But as LLV observe, wealth constraints may inhibit employees from constructing well diversified portfolios. There are two reasons for this. First, the number of stock options held by employees may be very high relative to their other investment holdings. Second, a large portion of the non-investment wealth of employees (especially managers) is tied to the firm. A top manager's salary, bonus, and other remuneration is at risk if the value of the firm drops.

Huddart assumes that employees' risk preferences are von Neumann-Morgenstern and that an employee's utility for wealth may be represented by the power utility function, $U(W) = W^{\tau}$, $\tau \in (0,1]$. An employee will exercise when the utility from the gain realized on exercise exceeds the expected utility from continuing to hold the option. Huddart shows that the stock price at which this condition is met is almost invariant to the remaining term of the option (for non-dividend paying stocks). This stock price ceiling can be estimated and used as an exercise rule in the binomial expansion. When the stock price reaches the ceiling, exercise is assumed and the branch is terminated.

Huddart limited his analysis to non-dividend paying firms. This enabled him to compare the estimates he obtained using the binomial model (with exercise assumed when the stock price reaches a ceiling determined by the level of risk-aversion) with Black-Scholes estimates.[7] He showed that Black-Scholes estimates overstate the fair value of ESOs when risk-averse exercise policies are adopted. This overstatement is reduced but not eliminated if the Black-Scholes estimates are made using the expected term of the options instead of the full option term.

---

[7]. Dividends add an additional level of complexity because risk-neutral traders may exercise an option on a dividend paying stock before the expiration of the option term.

Huddart did not consider the effect of risk aversion on the exercise of options on dividend paying stocks. Both dividends and risk preferences may cause employees to exercise before the expiration dates of their options. In this study I extend Huddart's analysis by considering the effects of both risk-aversion and dividends on the exercise of ESOs.

Practical application of Huddart's method for measuring the fair value of ESOs requires information about employees' levels of risk aversion. The effect of risk aversion on the fair value of ESOs varies considerably with the level of an employees' risk aversion. Huddart does not offer any empirical information about the level of risk aversion demonstrated by employees when making ESO exercise decisions. An interesting question addressed in the present study is, what level of risk aversion is demonstrated by employees when they make exercise decisions?

The FASB Stance

The Financial Accounting Standards Board has paid careful attention to the problem of early exercise in its study of employee stock options. In this section I provide a brief review of the history of accounting for employee stock options. I summarize the major arguments that the FASB has made in its exposure draft and its recent statement of accounting for stock-based compensation (FASB 1995). I also present a critical review of the FASB's proposed treatment of the early exercise problem.

Prior to the establishment of the Financial Accounting Standards Board (FASB), accounting standards were developed by the Accounting Principles Board (APB), a division of the American Institute of Certified Public Accountants. The APB performed a study of accounting for employee stock options leading to a pronouncement in 1972. This pronouncement, APB 25, preceded the development of the Black-Sholes option pricing models and the related finance literature.

For most employee stock options, APB 25 requires the recognition of compensation cost for the amount by which the stock price exceeds the exercise price at the time that options are granted. This value, $S - X$, is called the "intrinsic value" of the options. For options where the intrinsic value is zero or negative, no compensation cost is recognized. This means that no compensation cost is recognized for the large majority of ESOs where the exercise price is set equal to the stock price at the date of issue.

From finance theory and evidence, it is clear that such options have considerable value. Foster III, Koogler and Vickrey (1991) estimate that recognition of stock option value would have a material income effect for about 30% of non-dividend paying firms and 8% of dividend paying firms.

In response to the development of sophisticated option pricing techniques, the growth in popularity of ESOs as a form of compensation, and criticism of APB 25, the FASB added option compensation to its agenda in 1984. Underlying the FASB's consideration of accounting for employee stock options was the general notion of "fair value" accounting. Consistent with the transaction-based accounting model, the FASB wanted to develop an accounting method for ESOs that would recognize the fair value of the exchange of equity rights for employee services.

Two concerns were prominent in the FASB's deliberations. The first concern is a question of timing. When should the value of the exchange be measured? Three possibilities were identified: (1) at the date when ESOs are granted (the grant date), (2) at the date when the rights to ESOs are transferred to the employees (the vesting date), and (3) at the date when employees exercise (the exercise date). The second concern is a measurement issue. How should the value of the exchange be measured?

The timing and measurement issues are related. At the grant date, the measurement problem is most difficult. At the exercise date, the measurement problem is trivial (for publicly traded companies) because the fair value of the equity transferred can be measured by observing the market price of the stock on the exercise date.

The FASB chose the grant date as the measurement date because the exchange takes place with information available at the grant date. This selection is consistent with the argument that ESOs are a substitute for other forms of compensation (Sweeney 1960). Since the fair value of the equity rights transferred is more objectively measurable than the fair value of the services rendered by employees, the FASB decided to require fair value measurement of the ESOs at the grant date.

Grant date accounting may be criticized on two fronts. First, the exchange is incomplete because it depends on the employee fulfilling a service requirement (vesting). The FASB addressed this issue by allowing firms to estimate the expected number of ESOs that will vest or by recognizing the effect of forfeiture when it occurs.

Second, ESOs may be viewed as performance-based incentive compensation similar to bonuses. The value of cash bonus compensation is recognized after the performance conditions have been met. The FASB distinguished between stock price based incentive plans where the pay-out is made in cash (stock appreciation rights or SARs) and stock-based plans where ESOs are issued. In accounting for SARs, the increase in the intrinsic value of the SARs is recognized as it occurs. The primary difference between SARs and ESOs is that the exercise of an ESO involves a dilution of the equity of the firm. The FASB considers ESOs to be equity rights, not contingent rights to receive cash in the future. Therefore, the FASB decided that the fair value of ESOs at the grant date should be measured and allocated over the service period. No adjustment should be made for subsequent stock price changes.

The fair value of employee stock options is the value that the instruments would sell for in the marketplace. This does not imply that the market value of similar traded options should be used. Determination of fair value must recognize the expected exercise behavior of the holders of the options, the employees.[8]

The FASB considered a variety of option pricing methods but focused its attention on the Black-Scholes model and on Merton's lower bound or minimum value method. The binomial model was considered as a substitute for the Black-Scholes model. The FASB decided that the minimum value method was not appropriate for ESOs issued by publicly traded companies because it did not consider the "volatility component" of option value. The FASB statement recommends the minimum value method for non-public companies because of the absence of stock price information for estimating σ^2.

With respect to anticipated early exercise for dividend reasons or to satisfy risk and liquidity preferences, the FASB statement recommends that the expected term of ESOs be used instead of the actual term when applying the Black-Scholes or similar methods. This recommendation is troublesome because it is likely to lead to crude measurement of ESO value.

---

[8]. Since the employees cannot sell their options, the impact of their personal risk and liquidity preferences may only be manifest through exercise behavior.

Consider the effect of dividends on the valuation of traded stock options (TSOs). The Black-Scholes value (adjusted for expected dividend payments) assumes that the decision to exercise or not is made at the end of the option term. The European exercise constraint implicit in Black-Scholes valuation may cause understatement (not overstatement) of TSO value. The American right to exercise is valuable but is not recognized in the Black-Scholes model.

Black (1975) suggested an approximate procedure for measuring the value of an American option using the Black-Scholes formula. Black's procedure involved a comparison of (1) the Black-Scholes value when the full term of the option is used with (2) the Black-Scholes value when the term of the option is assumed to end just before the last ex-dividend date. The higher of the two values is used because the full-term Black-Scholes price may understate (but not overstate) the option value. With respect to early exercise for dividend reasons only, the expected term of a TSO should only be less than the full term if the effect of using the expected term is an increase (not a decrease) in the Black-Scholes value of the option.

Now consider the potential effects of risk and other liquidity preferences for employee stock option (ESO) valuation. As Huddart observed, a risk-averse exercise policy may cause employees to exercise at a lower stock price than would be suggested by Merton's exercise rules. Huddart's analysis also showed that the length of the remaining term of the option has almost no influence on the exercise decision. In other words, the decision to exercise depends on the stock price path, not the passage of time.

Determination of the joint effects of the firm's expected dividend policy and the employee's exercise policy on the expected term of the option is a complex task. The FASB statement recommends that the firm base its estimate of the expected life of an ESO on the past exercise history of employees. The use of historical exercise behavior for estimating the expected term for an employee group is dangerous because historical exercise behavior is uniquely associated with specific stock price movements, dividend changes and interest rate changes.

Adjusting the Black-Scholes estimate of ESO value by estimating an expected term opens the door for subjective measurement of ESO value. The FASB recognized the relationship between stock price movements and early exercise as illustrated by Huddart. In response, the final statement allows for the use of a ratio of stock price to exercise price as an exercise rule in the binomial model.

In this study, I use a more complete version of the binomial model that accommodates dividends and risk-averse exercise behavior. I extend Huddart's work by providing empirical information about the timing of exercise decisions relative to the risk-neutral exercise point. The information obtained from this analysis will provide useful guidance for measuring the fair value of ESOs.

Private Information and Early Exercise

A third potential reason (other than dividends and risk or liquidity preference) for early exercise of employee stock options has not been addressed in the accounting literature on measurement of ESO value. Employees may exercise early because they believe that the stock is overpriced by the market. In Merton's analysis of traded stock options, market traders who believe the stock price is too high do not have to exercise early to settle their option positions. They are better off to simply sell their options to other traders who believe the stock is not overpriced.

If employees have private information that leads them to believe that the stock price is too high, they cannot sell her ESOs to a third party. To take advantage of their information, they must exercise their options and sell the underlying stock. The exercise of ESOs and subsequent sale of the stocks are insider trades. Such trades are monitored by the Securities and Exchange Commission. The use of private information for personal gain when making sales of stock is generally not permitted under the securities laws of the United States. Under Section 16(b) of the Securities and

Exchange Act of 1934 insiders must disclose material facts which are known by them by virtue of their position, but are not known by those with whom they trade, if the facts would affect the investment judgement of those with whom they trade. Nonetheless, insider trades are closely watched by market participants for signals about future events.

Insiders must be very careful not to trade before the release of specific information when the information release may cause the stock price to change. For this reason, many firms restrict exercise of employee stock options to short periods following the disclosure of quarterly earnings. Increased insider trading is observed following corporate announcements such as dividend changes, capital expenditures, and equity issues or repurchases. John and Mishra (1990) suggest that such insider trading may provide a complementary signal that strengthens the signal provided by these other events.

Employee stock options put top managers in a precarious position because they force managers to trade. In a sense, even decisions to hold options are trades. Chrysler executives were criticized recently because there appeared to be a slowdown in the rate at which they were exercising options in the months before investor Kirk Kerkorian made a bid for Chrysler. The speculation was that Chrysler executives knew about Kerkorian's plans and stopped selling.

Presumably, top managers are highly skilled at collecting and analyzing relevant information for making decisions that affect the success of the firm. These managers also have special access to information about the firm and its prospects. The combination of skill and access to information puts these managers in unique positions for valuing the firm. However, managers are constrained from disclosing much of the private information they collect. For example, managers are reluctant to disclose information that would damage the firm's competitive position.

An important question is whether or not managers use the private information they collect when making exercise decisions. It would be difficult for them not to use private information in their exercise decisions unless they simply follow a pre-specified exercise policy. The careful tracking of insider trades by investment services reflects a belief held by many market participants that managers do reveal private information when they trade.

Opportunistic or speculative trading by managers is not necessarily undesirable. An argument in favor of insider trading is that information may be efficiently conveyed to the market through insider trades. Leland (1992) addressed the question of whether or not insider trading should be prohibited. Under Leland's assumptions, total welfare may or may not be increased with insider trading. He finds that stock prices contain more information and average stock prices are higher when insider trading is permitted. With insider trading in Leland's model, the firm's average profits from financing new real investment are higher and the level of real investment may increase. However, outside investors' welfare is lower with insider trading even though their average demand for stocks may increase. The liquidity of markets is reduced and liquidity traders suffer a welfare loss when insider trading is allowed.

The issuance and subsequent exercise of employee stock options is different from unrestricted trading by insiders. Outside stockholders can monitor the number of ESOs held by insiders because stock option plans must be approved by stockholders. When stockholders approve a stock option plan they may anticipate that managers will use private information when deciding whether to exercise or hold the options.

The type of information trading considered in this study differs from information trading around a specific event or disclosure. This study considers a manager's valuation of the firm based on all of the information possessed by the manager. This permits a much more general investigation of the use of private information by managers than an investigation that isolates a specific piece of information.

CHAPTER 3
DEVELOPMENT OF HYPOTHESES

The objective of this study is to investigate alternative explanations for early exercise of employee stock options. Three potential causes of early exercise were identified in the previous chapters: (1) exercise to obtain a dividend payment (Merton 1973), (2) exercise prompted by risk aversion or liquidity preference (Huddart 1994), and (3) exercise because the informed employee believes that the stock price is too high. The implications for measuring the fair value of employee stock options at the issue date are different for each of these causes.

Early Exercise to Obtain a Dividend Payment

Holders of call options are not entitled to dividends paid on the stock during the option term. Merton (1973) showed that when an expected dividend payment is large enough to offset the benefits of continuing to hold the options, the option holder will exercise to obtain the dividend. This makes the right to exercise before the end of the option term valuable for dividend paying stocks. The implication is that the value of an American option on a dividend-paying stock is greater than the value of a European option on the stock.

To study alternative explanations for early exercise, the effect of dividends on the timing of exercise must be considered. The flexibility of the binomial model (Cox, Ross, and Rubinstein 1979) enables consideration of the joint effects of dividends and exercise behavior on the valuation of American options.

Early Exercise due to Risk Aversion or Liquidity Preference

Huddart (1994) analyzed the effect that adoption of risk averse exercise policies would have on the fair value of ESOs at the issue date. The key to his analysis was the development of an exercise rule that incorporated the risk preferences of employees. For non-dividend paying stocks, he showed that risk-averse exercise is driven primarily by the relationship of the stock price to the exercise price, not by the remaining term of the option. This makes it possible to use a stock price ceiling as the exercise rule in a binomial expansion.

An alternative means for incorporating risk preferences is to make the exercise decision at every node in the binomial expansion dependant on a utility assessment at that point. A numerical comparison can be made between the expected utility the employees would receive from continuing to hold the options and the utility they would obtain from exercising the options at specific decision nodes. When the utility of the gain on exercise exceeds the expected utility of continuing to hold the options, exercise is assumed. This approach may be applied to options on dividend paying stocks as well as options on non-dividend paying stocks.

Following Huddart, assume that employees' risk preferences are von Neumann Morgenstern and that their utility may be expressed using the power utility function, $U(W) = W^{\tau}$, $\tau \in (0,1]$. Also, assume that stock price movements are binomial and that dividends are paid continuously. With these assumptions, the fair value of ESOs (from the firm's perspective) may be determined numerically using the binomial estimation method with a utility-based exercise rule.

Table 3-1 shows estimates of the fair value of ESOs issued for a ten year term with an exercise price equal to the market price of $50.[1] In table 3-1, panel A, the level of volatility is set at 0.20 which is lower than the average for the firms in my sample (about 0.30). In panels B and C, the level of volatility is set at 0.30 and 0.40 respectively.

The estimates of fair value in table 3-1 vary with the level of τ.[2]. The changes in fair value are not continuous because the stock price movements within the binomial expansion are discrete. A small change in the level of τ may not be sufficient to alter the pattern of exercise decisions for a particular binomial expansion.

---

[1]. Buenaventura and Peck (1993) find that most ESOs are issued with a term of 10 years or more (87% of the firms in their sample) and the great majority of ESOs (97% in their sample) are issued with an exercise price equal to the market price at the date of issue.

[2]. Within the context of the power utility function, τ may be described as the coefficient of risk aversion. A value of $\tau = 1$ corresponds to risk-neutrality, values of $\tau < 1$ ($\tau > 1$) correspond to risk-aversion (risk-loving). In the empirical part of this study, I interpret τ as an exercise timing parameter because the timing of exercise may be influenced by liquidity preferences other than risk preferences.

Various observations can be made from the three panels of table 3-1. As Huddart shows, the effect of risk aversion on the fair value of employee stock options may be quite large. For employees with low levels of τ and options on low dividend paying stocks, the binomial estimate (adjusted for τ) is less than half of the Black-Scholes estimate (not adjusted for τ). The Black-Scholes estimate (shown at the bottom of each panel in table 3-1) is made using the actual term of the option and a continuous dividend payment assumption.

Notice that when the dividend rate is high, the Black-Scholes estimate is less than the risk-neutral ($\tau = 1$) estimate obtained using the binomial method. Recall that the American right to exercise early is valuable but is not recognized by Black-Scholes estimation.[3] The undervaluation is greater when the level of volatility is higher (panels B and C). Consider, for example, a dividend paying stock with a volatility level of 0.3 (panel B) and a continuous dividend rate equal to the risk-free rate of 5% annually. The Black-Scholes price is $11.10. This is nearly the same as the binomial price when τ is 0.5. Reducing the Black-Scholes price of this option by using the expected term (as suggested by the FASB) instead of the actual term would lead to great understatement of the fair value unless the employees were very risk-averse.[4]

---

[3] The Black-Scholes estimates in these tables use the full term, not the expected term of the options. If the expected term were used, the Black-Scholes estimates would be smaller and the understatement of option value would be larger.

Vesting may have two effects on the fair value of an ESO at the issue date (in addition to the reduction in expected cost caused by employee turnover). If vesting delays early exercise prompted by risk aversion (or liquidity preference), then it increases the fair value from the firm's perspective at the issue date. If it delays exercise for dividend reasons, then it decreases the fair value from the firm's perspective at the issue date.

The estimates presented in table 3-1 do not consider vesting. Table 3-1 can be reconstructed with a vesting assumption. Table 3-2 presents the estimates of the fair value of options when a three year vesting period is imposed and the expected level of volatility is 0.3 (comparable to table 3-1, panel B). A comparison of table 3-1 and table 3-2 reveals that, at lower levels of τ, vesting increases the fair value of the options at the issue date. This occurs because vesting restricts employees from exercising as early as they would like to.

---

[4]. If an expected term of 7 years were used to value this option using the Black-Scholes method, the estimated value would be $10.90.

The estimates presented in tables 3-1 and 3-2 highlight the need for empirical information about the level of τ demonstrated by employees when making exercise decisions. An important research question is whether or not employees typically exercise when τ is less than 1.

The estimates of the binomial values in Tables 3-1 and 3-2 were obtained by adding a single additional parameter to the usual set of variables and parameters required for estimating the value of a TSO. It follows that, if the fair value of an ESO were known, the value of τ could be implicitly derived using a numerical procedure.[5]

When employees exercise ESOs, an approximation of the fair value of the remaining option rights is revealed. It is equal to the gain realized by the employees at the date of exercise. Consider, for example, employees who exercise ESOs at an exercise price of $50 when the remaining term of the ESOs is 5 years and the market price of the underlying stock is $75. The gain realized on exercise of each option is $25. By exercising at this point, the employees reveal that their utility for the $25 gain is equal to or greater than their utility for the remaining option rights.

---

[5]. Huddart's analysis was phrased in terms of risk aversion. Since other liquidity preferences (eg. desire for cash) may affect the timing of exercise, the level of τ revealed by exercise decisions may reflect a combination of risk aversion and other preferences. For this reason, I use the term "exercise timing parameter" to identify τ.

Under the following assumptions, employees' exercise decisions reveal the level of τ: *(1) employees exercise when their utility for the gain on exercise is equal to or slightly greater than their expected utility from continuing to hold the options, (2) employees use the current stock price as their measure of the value of the underlying stock.*

The first assumption would hold if stock price movements were continuous and the employees could exercise at the first point where their utility for the gain exceeds their expected utility from holding the options. Since stock price movements are not necessarily continuous and the employees may be restricted from exercising at all times, this assumption may only hold approximately. The second assumption holds if employees' assessment of the value of the firm is taken from the market price of the stock (without consideration of private information).

With data from actual exercise decisions and with the above two assumptions, the exercise timing parameter (τ) for employees' exercise decisions can be implicitly measured with the binomial model (adapted to incorporate a utility-based exercise rule). This is accomplished by setting the expected utility of the remaining option rights equal to the utility of the gain realized on exercise. The hypothesis that employees exercise before the risk-neutral exercise point ($\tau < 1$) can be investigated by estimating the exercise timing parameter for a sample of employees.

Hypothesis 1: The mean level of the exercise timing parameter (τ) revealed by employee exercise decisions is less than one.

Exercise before the risk-neutral exercise point may be due to employees' personal preferences for risk and liquidity or it may be the result of speculative trading by employees. The effect of speculative trading on information is considered next.

Early Exercise and Speculative Trading on Information

For employees to make speculative trades on information, the employees must have non-public information and they must believe that the stock price would change if the information were revealed. Private information that causes employees to believe that the stock is overpriced is referred to in this study as "negative" private information and private information that causes employees to believe that the stock is underpriced is referred to as "positive" private information. An employee's private information may also be "neutral". Employees that have positive or neutral private information would not exercise and sell for information reasons (they may for other reasons). Therefore, exercise and sell decisions that are affected by private information must be negative information trades.

The level of τ revealed by an exercise decision provides an indication of the manager's incentive to trade for non-information reasons at the time of the exercise decision. If the observed τ is very low (much smaller than 1), the manager exercised at a stock price that is much less than the stock price at which a risk-neutral trader would exercise. This implies that, at the time of the exercise decision, the manager had less incentive to trade for non-information reasons than the manager would have at a higher level of τ.

When the observed τ is around or above the risk-neutral exercise point ($\tau = 1$), the manager exercised at a stock price that is equal to or above the stock price that a risk-neutral trader would exercise at. In these situations, the manager had strong incentives to trade for non-information reasons.

Exercise and sell decisions that occurred when managers had weak incentives to trade are more likely to be information trades than exercise and sell decisions that occurred when the managers had strong incentives to trade. Thus, exercise and sell decisions where the observed τ is low are more likely to be information trades.

Consider three groups of exercise decisions: (1) exercise decisions made when τ is low, (2) exercise decisions made when τ has a value around one, and (3) exercise decisions made when τ is high. Based on the above argument, exercise decisions in group (1) are more likely to be information trades than exercise decisions in groups (2) and (3).

If private information does not influence exercise decisions, there is no basis for predicting different stock price movements after exercise for the three groups. If private information does influence exercise decisions, then stock price declines are more likely to follow exercise decisions in group (1) than exercise decisions in groups (2) and (3).

Hypothesis 2: Stock price declines are more likely to follow exercise decisions that occur at low levels of τ than other exercise decisions.

A related hypothesis is that the average price change after exercise should be lower (less positive or more negative) for exercise decisions in group (1) than for exercise decisions in the other groups.

Hypothesis 2A: Stock price changes following exercise are lower for exercise decisions that occur at low levels of τ than for other exercise decisions.

A primary concern of this study is whether or not risk and liquidity preferences lead managers to exercise before the risk-neutral exercise point. Information trading provides an alternative explanation (to risk or liquidity preferences) for exercise before the risk-neutral exercise point.[6] A simple test of hypothesis 1 (whether or not managers exercise before the risk-neutral exercise point) cannot distinguish between exercise for information reasons and exercise for risk or liquidity reasons.

---

[6]. Huddart's argument is that exercise policies that cause early exercise for risk or liquidity reasons reduce the fair value of ESOs. This argument does not necessarily apply to speculative exercise policies adopted by informed managers. Managers who exercise options early because they have negative private information beat the market when they sell their shares. They reap a speculative profit from whoever buys the shares.

An ex-post method for identifying exercise decisions that are likely to be information trades is to examine subsequent stock price performance. Exercise decisions that are followed by negative stock price performance are more likely to be information trades. Exercise decisions that are followed by non-negative stock price performance are less likely to be information trades. When the sample is restricted to exercise decisions that are followed by non-negative stock price performance, a stronger test of the hypothesis that risk and liquidity preferences influence exercise decisions by managers can be conducted.

Hypothesis 3: When only those exercise decisions that are followed by non-negative stock price performance are included, the mean level of the exercise timing parameter (τ) revealed by employee exercise decisions is less than one.

The technique used to measure τ, a description of the sample data and the observed distribution of τ are given in chapter 4. The observed distribution is used to test hypothesis 1. Tests of hypotheses 2 and 3 are presented in chapter 5.

TABLE 3-1, Panel A: Binomial estimates of the fair value of 10 year employee stock options issued at $50 when volatility is 0.20 and the risk-free rate is .05. DIV is the dividend rate and τ is the exercise timing parameter.

	DIV=0	DIV=.01	DIV=.03	DIV=.05	DIV=.07
τ = 1	22.07	18.27	12.05	8.28	5.63
τ = 0.9	22.07	18.27	11.99	7.26	5.56
τ = 0.9	22.07	18.24	11.99	8.21	5.56
τ = 0.7	21.66	18.07	11.41	7.67	5.56
τ = 0.9	21.66	17.26	11.41	7.59	5.56
τ = 0.9	21.57	15.55	11.41	7.26	4.32
τ = 0.4	18.97	14.51	9.53	5.49	4.10
τ = 0.3	15.30	12.06	9.53	5.34	4.10
τ = 0.2	11.68	7.59	6.34	4.82	4.10
τ = 0.1	8.53	7.59	6.05	4.82	4.10
Black-Scholes price (τ = 1)	22.59	18.56	12.00	7.54	4.51

Panel B: Binomial estimates of the fair value of 10 year employee stock options issued at $50 when volatility is 0.30 and the risk-free rate is .05. DIV is the dividend rate and τ is the exercise timing parameter.

	DIV=0	DIV=.01	DIV=.03	DIV=.05	DIV=.07
τ = 1	25.71	22.12	16.71	12.67	9.78
τ = 0.5	25.04	22.03	16.36	12.67	9.73
τ = 0.8	25.04	21.34	16.36	12.17	9.69
τ = 0.7	23.37	20.19	16.36	11.84	9.45
τ = 0.5	21.61	19.39	14.35	11.84	9.45
τ = 0.5	20.01	17.23	19.39	11.46	7.45
τ = 0.4	17.54	16.74	10.82	8.95	7.45
τ = 0.3	12.05	11.10	9.38	8.26	6.82
τ = 0.2	12.05	11.10	9.26	8.26	6.82
τ = 0.1	12.05	11.10	9.26	7.89	6.82
Black-Scholes price (τ = 1)	26.28	22.34	15.90	11.10	7.63

TABLE 3-1 - continued, Panel C: Binomial estimates of the fair value of 10 year employee stock options issued at $50 when volatility is 0.40 and the risk-free rate is .05. DIV is the dividend rate and τ is the exercise timing parameter.

	DIV=0	DIV=.01	DIV=.03	DIV=.05	DIV=.07
τ = 1	29.45	25.59	20.84	17.00	13.64
τ = 0.5	29.11	25.59	20.72	17.00	13.64
τ = 0.8	27.27	24.62	20.50	16.14	13.44
τ = 0.8	26.50	23.85	18.70	15.81	13.25
τ = 0.6	23.32	21.61	18.70	15.81	10.72
τ = 0.5	22.76	21.06	14.13	12.50	10.72
τ = 0.4	15.38	14.43	12.59	11.65	10.00
τ = 0.3	15.38	14.43	12.59	11.23	10.00
τ = 0.2	15.38	14.43	12.59	10.98	10.00
τ = 0.1	15.38	14.43	12.59	10.98	9.59
Black-Scholes price (τ = 1)	30.08	26.10	19.50	14.43	10.62

TABLE 3-2: Binomial estimates of the fair value of 10 year employee stock options issued at $50 when volatility is 0.30 and the risk-free rate is .05. DIV is the dividend rate and τ is the exercise timing parameter. A 3 year vesting period is imposed.

	DIV=0	DIV=.01	DIV=.03	DIV=.05	DIV=.07
τ = 1	25.71	22.12	16.71	12.67	9.78
τ = 0.9	25.70	22.03	16.46	12.67	9.78
τ = 0.9	25.05	21.34	16.36	12.67	9.78
τ = 0.7	23.37	20.19	16.36	12.17	9.36
τ = 0.9	21.61	16.36	15.13	11.90	9.36
τ = 0.9	20.01	18.55	15.13	11.73	9.05
τ = 0.4	18.93	17.99	15.13	11.73	9.05
τ = 0.3	16.42	14.77	11.75	9.66	7.16
τ = 0.2	16.42	14.77	11.58	9.66	7.16
τ = 0.1	16.42	14.77	11.58	9.12	7.16
Black-Scholes price (τ = 1)	26.28	22.34	15.90	11.10	7.63

CHAPTER 4
EMPIRICAL ESTIMATION OF THE EXERCISE TIMING PARAMETER

An innovation of this research study is the use of the binomial option pricing model (Cox, Ross, and Rubinstein 1979) to measure the value of an exercise timing parameter revealed by an employee's exercise decision. Following Huddart (1994), an employee's utility may be represented by the power utility function, $U(W) = W^{\tau}$, $\tau \in (0,1]$. Assuming that the employee's risk preferences are von Neumann-Morgenstern, exercise of an ESO depends on a comparison of the utility to be realized from the gain on exercise with the expected utility of continuing to hold the option. The expected utility of continuing to hold the option is the weighted sum of the utilities of the present values (discounted at the risk-free rate) of each probable future gain on exercise. Exercise occurs when the utility of the gain to be realized on exercise slightly exceeds the expected utility of continuing to hold the option. This relationship is described below.

Let S_T represent the current stock price and let S_i represent the estimated stock price at node i of a binomial expansion. Let X represent the exercise price of the option. Then, $S_T - X$ is the gain realized on exercise at the current date T, and $S_i - X$ is the gain to be realized by exercise at node i. Let $\alpha_i(\tau)$ represent the probability that the option will be exercised (or terminate) at node i given the value of the employee's exercise timing parameter τ. Note that many nodes will have $\alpha_i(\tau) = 0$ because the employee will prefer to wait rather than exercise. Also, note that some terminal nodes (nodes at the end of the option's life) will have $\alpha_i(\tau) > 0$ even though $S_i < X$. For these nodes, the gain to be realized is set equal to 0.

If the employee's exercise timing parameter is known, the employee's utility for exercising at time T may be represented by

$$U_T = (S_T - X)^{\tau}$$

The employee's expected utility from continuing to hold the option may be represented by

$$EU_T = \sum_i \alpha_i(\tau) * ((S_i - X) * e^{-r_i t_i})^{\tau}$$

where r_i is the risk-free rate for period t_i which is the length of time from time T until node i. The employee exercises at time T if $U_T \geq EU_T$.

Assume that employees behave as specified above. Before the employee exercises, $U_T < EU_T$. If stock price movements are assumed to be continuous, the employee will exercise an

American option when $U_T = EU_T$.[1] This relationship provides the basis for empirical estimation of τ.

The gain realized on exercise, $S_T - X$, is observable. A set of possible future gains on exercise, $S_i - X$, can be described by a binomial expansion beginning at time T and ending at the end of the remaining option life. Specification of this expansion requires information about the expected stock return volatility, expected dividend payments, and the risk-free rate of interest for the remaining term. All of these parameters can be estimated using observable information. The sole remaining variable is the exercise timing parameter τ which can be implicitly measured using a numerical procedure that sets $U_T = EU_T$.

In the remainder of this chapter I describe the sample of exercise decisions used, the procedures used to estimate the volatility, dividend and interest rate parameters, and the distribution of the observed values of the exercise timing parameter. The observed distribution of the exercise timing parameter provides information for evaluating the first hypothesis of chapter 3 (that managers exercise before the risk-neutral exercise point).

---

[1]. Since stock price movements are not continuous, this relationship only holds approximately.

Sample selection and data collection

The sample contains exercise decisions made by executives in 1992 and 1993. This time period was selected because proxy statements issued for these years contain detailed information about the option holdings of individual executives.[2] This information includes the number of options issued during the current year and the previous two years, the number of options exercised during the current year and the gain realized on exercise, and the number of options remaining in the manager's portfolio at the end of the year.

Proxy statements issued for years preceding 1992 contain limited information on employee stock options. In most cases, only the number of new options issued, the exercise price of the new options and the gain realized on the exercise of old options is reported. However, by combining the information in the 1992 and 1993 proxy statements with the information contained in proxy statements for the preceding ten years I was able to build a history of the option portfolio of many executives.

Specifically, I was able to determine the following information for options exercised during 1992 and 1993: (a) the year that the options were initially issued, (b) the term the options were initially issued for, (c) the exercise price of the options, and (d) the gain realized on exercise. The market price at the date of exercise is calculated by adding the exercise price to the gain realized on exercise.[3]

---

[2]. New disclosure rules on executive compensation were instituted by the Securities and Exchange Commission for 1992 and subsequent years.

Some assumptions were required in assembling the data for each manager. Primarily, I assumed that options were exercised in a rational order. Options with a lower exercise price were assumed to be exercised first in most cases.[4] For example, if options were issued in 1988 at an exercise price of $20, and options were issued in 1989 at an exercise price of $15, I assumed that the 1989 options would be exercised first. If a specific term was not mentioned for options issued, I assumed that the option term was 10 years.[5]

The sample firms were selected from firms which had long-term options actively traded on their stocks during the years 1992 and 1993. This sampling decision was made because I wanted to be able to measure the implied volatility of stock returns for each firm around the date of exercise (using the

---

[3]. The market values inferred from the exercise price and the gain realized on exercise (reported in the proxy statements) were subsequently compared with the market prices reported in the *Official Summary of Security Transactions and Holdings* prepared by the SEC. In almost all cases, the two values were the same or very close to each other.

[4]. Options which would otherwise expire were assumed to be exercised if the market price exceeded the exercise price.

[5]. In their survey, Buenaventura and Peck (1993) found that 87% of the ESOs that they examined were issued for terms of 10 years or more.

Black-Scholes formula).[6] Obtaining a reasonably accurate measure of the expected stock return volatility near the date of exercise is important because the exercise timing parameter (τ) is sensitive to the stock return volatility.

I began with a sample of 83 firms which included virtually all of the firms that had long-term options traded (and reported in the *Wall Street Journal*) for a reasonable period of time during both 1992 and 1993. The final sample includes 366 exercise decisions made by 218 executives at 71 firms. An exercise decision is defined as the exercise of options that were issued in a specific year. A specific executive may have more than one exercise decision in either 1992 or 1993. For example, in 1992 the same executive may exercise options that were issued in 1984 and 1986.[7]

Nine firms were eliminated because no executives made exercise decisions during 1992 and 1993 (eg. IBM). Information from three other firms wasn't used because insufficient data was available. Information on certain executives could not be used because the executive did not have a sufficiently long history in the proxy statements. Twenty-five exercise decisions were not used because exercise occurred at the end of the option term. At the end of the term, executives will exercise if the market price of the stock exceeds the exercise price of the option. No inference can be made about the level of τ in this situation.

---

[6] This suggestion was made by Larry Merville. He recommended measurement of the implied level of volatility for near-the-money long-term options (see MacBeth and Merville 1979 and 1980).

[7] An executive's portfolio of stock options includes numerous sets of options received at various dates and at various exercise prices (depending on the market price of the stock at the issue date). During any given period, executives will exercise a portion of the options in their portfolios. Option exercise decisions are made independently for each specific set of options in the manager's portfolio.

A list of the 71 firms in the final sample is provided in table 4-1. Most of the firms are large and they are spread out reasonably well across industries. The average cash compensation for executives included in the sample is $980,000 per year. I did not use exercise decisions made by executives who retired or quit before the proxy statements were issued (usually three or four months after the year end). Executives who retire or quit may be forced to exercise options in accordance with their employment agreements.

In addition to the compensation information, I collected information on long-term options traded for each firm. To obtain this information I searched the *Wall Street Journal* daily listing of long-term options to find near the money options. For each firm collected enough observations of near the money options to calculate an implied level of volatility for one day of each month during 1992 and 1993.

The maximum term of the long-term options was three years and most had between one and two years remaining at the observation date. The trading price of the option, the exercise price and term of the option, the market price of the stock, and the interest rate on government securities for the term of the option were obtained from daily information in the *Wall Street Journal*. Expected dividends were estimated using a history of dividend information obtained from *Compustat*.

The Black-Scholes formula (adjusted for expected dividends during the option term) was used to calculate the implied volatility. The implied volatility used in the binomial estimations of τ is the average of all of the implied volatilities calculated for a specific firm during the year of exercise. This averaging was done to increase the reliability of the measure and to control for movements in the implied level of volatility caused by specific events occurring during the year such as earnings announcements. For most firms, but not all, the implied volatility is reasonably close to the historic volatility based on a 60 month history of stock returns (see table 4-1).

Measuring τ

Binomial estimation (Cox, Ross, and Rubinstein 1979) of the market value of an option on a dividend paying stock requires the following: (a) the exercise price of the option, (b) the market price of the stock, (c) the remaining life of the option, (d) an estimate of the expected stock return volatility for the option term, (e) an estimate of the risk-free rate of return for the option term, and (f) the expected dividend rate or dividend payments.

I obtained (a), (b), and (c) from the proxy statements as described in the preceding section. I used two volatility measures, the implied volatility as determined by the procedure described above, and historic volatility based on stock returns for a five year period preceding the middle of the fiscal year in which the exercise occurs. The risk-free rate of return was estimated using the yield rate on U.S. government bonds for the option term.

I adopted a continuous dividend assumption and used historic dividends to estimate the expected dividend rate. The rate was measured in two steps. For a series of four years ending with the year of exercise, the dividends paid during a year were divided by the mid-point of the stock price during the year (i.e. the average of the minimum and maximum price during the year). Then, the four annual rates were averaged to give the dividend rate used in the study.

Taxes are not specifically included in the analysis. Almost all of the options in the sample were non-qualifying stock options. Employees are taxed at ordinary rates on the gain realized at the date of exercise. Employees receive a small tax deferral benefit by delaying the exercise of ESOs. Before the options are exercised, they earn a taxable return on the gross investment. After they are exercised, they earn a taxable return on the net after-tax proceeds. This tax deferral benefit provides an incentive for employees to hold options, so it may have a countervailing effect against risk or liquidity preferences. An anticipated change in tax rates may also affect the timing of exercise.[8]

For each exercise decision, I prepared a computer spreadsheet of the binomial expansion of the remaining option term at the date of exercise. An optimization procedure was used to find the level of τ that equated the utility of the gain realized on exercise with the expected utility of the remaining option rights. The procedure was done using both the implied measure of volatility and the historic measure.

Distribution of τ

A frequency distribution of the observed τ's for the sample of exercise decisions is presented in figure 4-1 (for estimations made using the implied level of volatility). The median of the distribution is 0.9 and the distribution corresponds reasonably well to a normal distribution. The distribution in figure 4-1A is generated using estimates of expected volatility based on historic stock returns. It is also centered at 0.9.

The observed mean level of the exercise timing parameter is 0.922. Assuming normality, this is significantly less than 1.0 (the standard error of the mean is 0.020). This is consistent with hypothesis 1 (that executives typically exercise before the risk-neutral exercise point). However, the difference between an exercise timing parameter of 0.9 and an exercise timing parameter of 1.0 lacks economic significance in the context of estimating the fair value of employee stock options. This can be seen by referring back to table 3-1. There is very little difference between the binomial estimates when $\tau = 1$ and the binomial estimates when $\tau = 0.9$.

---

[8] There is a possibility that executives may have exercised early in 1992 in anticipation of higher tax rates under the Clinton administration. If this were true, there would be a downward bias in the observed levels of the exercise timing parameter.

A reasonably large proportion of exercise decisions are made when τ is substantially lower than 1. For example, 37% of the exercise decisions in figure 4-1 were made when the value of τ was less than 0.8, and 17% of the exercise decisions were made when the value of τ was less than 0.6.[9] The number of exercise decisions made at low levels of τ supports the notion that some managers exercise well before the risk-neutral point.

Interestingly, a relatively large number of exercise decisions take place after the risk-neutral exercise point. Referring again to figure 4-1, 21% of the exercise decisions were made when the value of τ was greater than 1.2. Various explanations may be offered for this behavior. First, top managers may hold options to provide a signal that they are confident in their ability to move the stock price up. Second, managers who speculate may hold onto options because they have private information that leads them to believe that the stock is underpriced. Third, a large discrete jump in the stock price may have occurred before the manager exercised.[10] Fourth, managers may hold onto options to take advantage of the tax deferral benefit described earlier.

---

[9]. Since the sample includes only observed exercise decisions, these proportions represent an upper limit of the estimated exercise decisions made by certain levels of τ. Many options expire without being exercised (not included in the sample).

The observed median level of τ is lower for 59 options exercised on non-dividend paying stocks (see figure 4-2). For non-dividend paying stocks, the observed median is 0.683 and the mean is 0.64. Since the optimal risk-neutral exercise point for a non-dividend paying stock is at the end of the life of the option, the observed τ could not exceed 1 for non-dividend paying stocks. Over 25% of the options on non-dividend paying stocks (15/59) are exercised very close to the risk-neutral exercise point.

A Note on Vesting

The observed level of τ could be overstated because of vesting provisions and other trading restrictions imposed on managers. Vesting may cause managers to hold ESOs longer than they otherwise would. The vesting period of ESOs issued before 1992 was not usually reported in the proxy statements.

---

[10] Managers are often restricted from exercising except during certain time periods. General Electric, for example, restricts exercise of options to 10 day windows of time just after earnings are announced.

Therefore, vesting was not incorporated in the empirical analysis. However, the vesting period of options granted in 1992 and 1993 is reported by most companies. Assuming that vesting provisions remain stable over time, some inferences can be made from the data.

If I use the maximum vesting period reported for each firm (using the vesting provisions of 1992 and 1993), then 146 of the 366 exercise decisions included in the sample could have been delayed because of vesting provisions. The average level of τ estimated for these exercise decisions is 0.75. The estimated τ exceeds 1.05 in just 9 of the 146 cases.

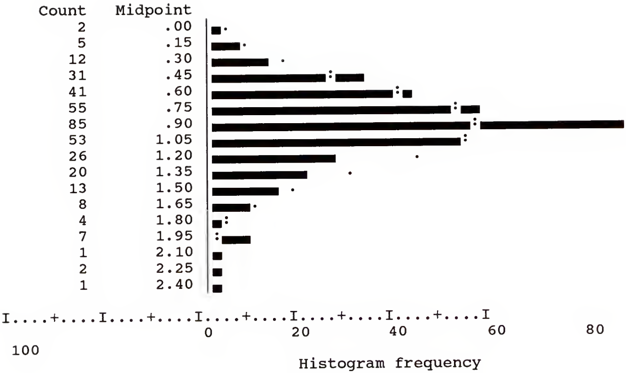
It appears that vesting may have caused some managers to wait before they exercised but vesting did not cause a significant number of managers to wait until after the risk-neutral exercise point to exercise.

TABLE 4-1: List of Companies and estimated stock return volatilities.

	Historic volatility 1992	Implied volatility 1992	Historic volatility 1993	Implied volatility 1993
ABBOTT LABORATORIES	0.19	0.27	0.19	0.29
ADVANCED MICRO DEVICES	0.60	0.54	0.60	0.49
ALLIEDSIGNAL INC	0.22	0.24	0.23	0.25
AMERICAN EXPRESS	0.30	0.38	0.30	0.3
AMERICAN HOME PRODUCTS CORP	0.16	0.24	0.17	0.23
AMGEN INC	0.36	0.39	0.45	0.42
AMR CORP/DE	0.32	0.3	0.30	0.27
ANHEUSER-BUSCH COS INC	0.20	0.23	0.21	0.25
AT&T CORP	0.22	0.24	0.21	0.21
BAKER-HUGHES INC	0.34	0.35	0.35	0.31
BANKAMERICA CORP	0.37	0.36	0.34	0.28
BOEING CO	0.25	0.3	0.25	0.27
BRISTOL MYERS SQUIBB	0.17	0.24	0.18	0.25
CAMPBELL SOUP CO	0.28	0.29	0.29	N/A
CHASE MANHATTAN CORP	0.39	0.38	0.39	0.3
CHUBB CORP	0.23	0.2	0.22	0.2
CITICORP	0.37	0.39	0.37	0.32
COCA-COLA CO	0.20	0.26	0.20	0.24
COMPAQ COMPUTER CORP	0.43	0.4	0.43	0.38
CONNER PERIPHERALS	0.53	0.45	0.56	0.49
DELTA AIR LINES INC	0.27	0.29	0.27	0.3
DIGITAL EQUIPMENT	0.35	0.37	0.37	0.37
DISNEY (WALT) COMPANY	0.24	0.28	0.26	0.27
DOMINION RESOURCES INC	0.13	0.13	0.11	N/A
DOW CHEMICAL	0.23	0.28	0.22	0.25
DU PONT (E.I.) DE NEMOURS	0.21	0.24	0.20	0.2
EXXON CORP	0.12	0.18	0.11	0.19
FORD MOTOR CO	0.27	0.33	0.27	0.29
FRUIT OF THE LOOM INC -CL A	0.39	0.33	0.42	0.37
GAP INC	0.41	0.39	0.38	0.35
GENERAL ELECTRIC CO	0.21	0.23	0.20	0.19
GTE CORP	0.18	0.23	0.17	0.21
HEINZ (H.J.) CO	0.20	0.26	0.21	0.22
HILTON HOTELS CORP	0.37	0.3	0.40	0.33
HOME DEPOT INC	0.28	0.2	0.28	0.32
INTEL CORP	0.36	0.36	0.36	0.35
JOHNSON & JOHNSON	0.20	0.27	0.23	0.27
K MART CORP	0.28	0.31	0.28	0.28
LIMITED INC	0.36	0.37	0.36	0.4
LIZ CLAIBORNE INC	0.34	0.35	0.36	0.33
MCDONALDS CORP	0.21	0.25	0.21	0.25
MCGRAW-HILL INC	0.22	N/A	0.21	0.21
MERCK & CO	0.19	0.27	0.21	0.33
MICROSOFT CORP	0.32	0.34	0.31	0.33
MOBIL CORP	0.15	0.2	0.15	0.18
MONSANTO CO	0.24	0.26	0.24	N/A
MORGAN (J.P.) & CO	0.25	0.29	0.24	0.23
MOTOROLA INC	0.30	0.28	0.28	0.3
NIKE INC -CL B	0.38	0.33	0.39	0.37
NYNEX CORP	0.16	0.18	0.17	0.25
ORACLE SYSTEMS CORP	0.59	0.53	0.59	0.52
PACIFIC TELESIS GROUP	0.19	0.19	0.20	0.18
PEPSICO INC	0.21	0.27	0.22	0.25
PFIZER INC	0.26	0.28	0.27	0.29
PHILIP MORRIS COS INC	0.20	0.26	0.26	0.29
PROCTER & GAMBLE CO	0.21	0.22	0.22	0.21
QUAKER OATS CO	0.22	0.23	0.23	0.28
REEBOK INTERNATIONAL LTD	0.43	0.43	0.42	0.39
REYNOLDS METALS CO	0.26	0.29	0.25	N/A
SUN MICROSYSTEMS INC	0.46	0.41	0.46	0.38
TEXAS INSTRUMENTS INC	0.37	0.35	0.36	0.4

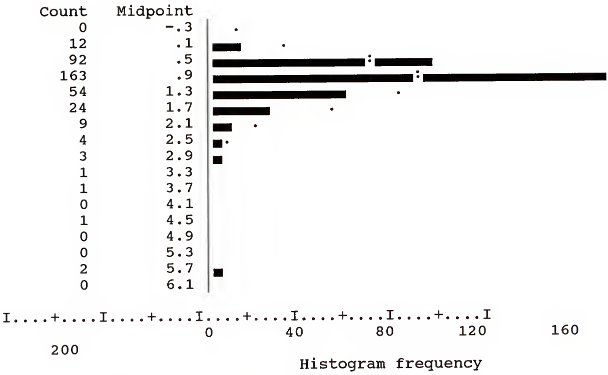
TABLE 4-1 - continued

	Historic volatility 1992	Implied volatility 1992	Historic volatility 1993	Implied volatility 1993
TIME WARNER INC	0.32	0.32	0.32	0.3
TRITON ENERGY CORP	0.55	0.5	0.55	0.41
U S SURGICAL CORP	0.33	0.39	0.46	0.48
UNION CARBIDE CORP	0.39	0.31	0.38	0.3
UNOCAL CORP	0.24	0.29	0.22	0.25
WAL-MART STORES	0.20	0.28	0.22	0.3
WELLS FARGO & CO	0.34	0.34	0.35	0.33
WMX TECHNOLOGIES INC	0.23	0.27	0.25	0.28
WOOLWORTH CORP	0.28	0.33	0.25	0.34
XEROX CORP	0.28	0.25	0.28	0.25
Mean	0.29	0.30	0.29	0.28
Std Dev	0.10	0.09	0.11	0.10



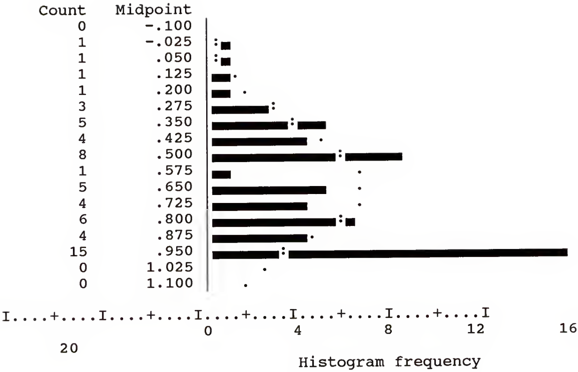
Median = 0.90, mean = 0.922, std err = 0.020.

FIGURE 4-1: Frequency distribution and histogram (normal distribution superimposed) of τ when the estimation of the binomial is made using implied volatility.



Median = 0.902, mean = 1.008, and std err = .033

FIGURE 4-1A: Frequency distribution and histogram (normal distribution superimposed) of τ when the estimation of the binomial is made using historic volatility.



Median = 0.683, mean = 0.640, and std err = .035

FIGURE 4-2: Frequency distribution and histogram (normal distribution superimposed) of τ for non-dividend paying stocks when the estimation of the binomial is made using implied volatility.

CHAPTER 5
TESTS OF THE INFORMATION HYPOTHESES

The distribution of the exercise timing parameters (τ) presented in chapter 4 (figure 4-1) indicates that some managers exercise ESOs much earlier than the risk-neutral exercise point. A question of interest is whether these managers are exercising very early because of risk and liquidity preferences or whether they are making speculative trades using private information about the firm.

A manager's information set may be partitioned into information that is privately held and information that is publicly available to all investors. A top manager should be able to discern whether a piece of information is known publicly and reflected in the stock price. In addition, the manager should be able to determine whether disclosure of the information would cause the stock price to rise or fall.

A manager making an exercise decision must either incorporate private information or ignore it. To ignore it, the manager must follow a predetermined exercise policy that uses publicly available information only. For example, the manager could use Merton's (1973) exercise rules. Merton's rules provide objective exercise functions based on the market price of the stock.

A manager whose exercise behavior is influenced by risk or liquidity concerns must make subjective adjustments to Merton's rules. This makes the exercise decision difficult for the manager who does not want to incorporate private information. To remain free from bias, the manager must determine how risk aversion and other preferences affect exercise without letting private information influence the decision-making.

In this chapter, I investigate the hypothesis that exercise decisions that occur well before the risk-neutral exercise point are influenced by managers' private information. A manager's private information is not observable. Therefore, a test of whether or not managers use private information when making exercise decisions must use information revealed to the market after the exercise decisions are made. Information revealed to the market after exercise will affect the stock price. If a manager makes a very early exercise decision based on negative private information, the stock price should fall when the information is revealed.

The first information hypothesis (hypothesis 2 in chapter 3) is that stock price declines occur more frequently after very early exercise decisions (exercise decisions that occur well before the risk-neutral exercise point) than after other exercise decisions. The second information hypothesis (hypothesis 2A) is that the average stock price change after exercise is lower for very early exercise decisions than for other exercise decisions.[1]

The exercise timing parameter, τ, equals one if an exercise decision is made at the risk-neutral exercise point. To test the two hypotheses, the data is separated into subsets based on the observed value of τ at the exercise date. For illustrative purposes, consider the following three groups: (1) $\tau < 0.6$ for very early exercise, (2) $0.6 \leq \tau \leq 1.4$ for a middle range surrounding the risk-neutral exercise point, and (3) $\tau > 1.4$. If exercise decisions are not influenced by private information, subsequent price changes should be similar across the three groups. However, if exercise decisions are influenced by private information, more negative information trades should be found in group 1 than in the other groups.[2] With information trading, a relatively greater number of exercise decisions in group 1 should be followed by price declines and the average price change for exercise decisions in group 1 should be lower than in the other groups.

The exact exercise dates of ESOs are not reported in the proxy statements. Only the number of options exercised during a year and the gain realized on exercise are reported for a manager. To obtain the exact dates of exercise I searched the *Official Summary of Security Transactions and Holdings* prepared by the Securities and Exchange Commission. From this summary I was able to identify exercise dates for 315 of the 366 exercise decisions analyzed in chapter 4.

---

[1] The average stock price change is used instead of the stock return (adding dividends) because ESOs do not entitle managers to dividends.

[2] As discussed in chapter 3, the managers' personal incentives to exercise (for risk or liquidity reasons) are higher in groups 2 and 3.

Tests of the information hypotheses require a comparison of stock price movements after exercise across the three groups of exercise decisions. The release of a manager's private information is not likely to occur immediately after exercise. Managers who exercise and sell their shares just before the release of bad news will attract SEC attention. For this reason, I use a variety of time periods after exercise in the analysis (ranging from 3 months to 18 months).

Table 5-1 presents the empirical results when the very early exercise group includes exercise decisions where the exercise timing parameter (τ) is less than 0.6. For this grouping, 38 of the 55 stocks (69%) in the very early exercise group ($\tau < 0.6$) exhibit a price decline between the date of exercise and six months following the date of exercise. This may be compared with 126 of the 229 stocks (55%) in the middle group ($0.6 \leq \tau \leq 1.4$) which exhibit a price decline. The difference in the proportions of price decline between these groups is significant at the 97.5% confidence level.

The mean price change for the very early exercise group ($\tau < 0.6$) is -5.57% for the 6 month period after exercise. The mean price change for the middle group ($0.6 \leq \tau \leq 1.4$) is

+1.78%. The difference between the mean price changes of 7.35% for these groups is significant at the 97.5% confidence level (one-tailed test). When a 12 month period after exercise is used, the mean price change for the very early exercise group (τ <0.6) is -6.03% and the mean price change for the middle group ($0.6 \leq \tau \leq 1.4$) is +8.34%. The difference between these mean price changes of 14.37% is significant at any reasonable confidence level. Over an 18 month period after exercise, the difference between the mean price changes is 14.81% (the mean return is -3.83% for the very early exercise group and 10.98% for the middle group). This indicates that the difference in mean stock price changes is persistent over time.

The differences in the proportions of price declines and the spreads between the mean price changes are much smaller during the 3 month period after exercise. This is consistent with the idea that managers make exercise decisions based on private information that will be revealed after some time has passed.

Tables 5-2 through 5-4 present the results for alternate groupings of the data. In tables 5-2 and 5-3, the very early exercise group is expanded to include higher values of τ (τ < 0.7 in table 5-2 and τ < 0.8 in table 5-3). As one would expect, the differences between the proportions and the means decline somewhat as the group is enlarged to include observations closer to the risk-neutral point. In table 5-4, the very early exercise group is contracted to include values of τ less than 0.5. This makes the sample of very early exercise decisions quite small (n=25), but the results hold.

The results presented in tables 5-1 through 5-4 support the two information hypotheses with respect to the very early exercise groups. The proportion of price declines are greater for the very early exercise groups when compared to the middle groups. This is consistent with the first information hypothesis. The mean price changes are much smaller for the early exercise groups than for the middle exercise groups. This is consistent with the second information hypothesis.

The results for the groups that exercise after the risk-neutral exercise point (eg. $\tau > 1.4$ in table 5-1) indicate that subsequent price changes are lower for these groups than for the middle exercise groups. This is contrary to the information hypotheses. A possible explanation is that a larger proportion of information traders (market timers) are found in the late exercising groups than in the middle groups.

The information hypotheses assume that employees exercise ESOs and then sell the shares acquired. Tables 5-1 through 5-4 present information based on 315 exercise decisions for which data was available in the *Official Summary of Security Transactions and Holdings*. These exercise decisions may or may not have been followed by sales of shares. I reviewed the *Official Summary* to check and see whether or not these exercise decisions were accompanied by immediate sales of the acquired shares. The majority (175 of 315) of the exercise decisions were accompanied by immediate sales of more than 50% of the acquired shares.[3]

Table 5-1 (where the very early exercise group is determined by $\tau < 0.6$) and table 5-3 (where the very early exercise group is determined by $\tau < 0.8$) are reproduced as tables 5-5 and 5-6 for the 175 exercise decisions that are accompanied by immediate sales of more than 50% of the acquired shares. The information found in these tables is consistent with the information found for the full sample of 315 firms.

An absence of data on vesting periods made it impossible to include vesting in the empirical analysis. This does not reduce the strength of the tests. If vesting has any influence on the timing of exercise decisions, it causes employees to wait longer than they otherwise would to exercise. Vesting may have pushed some information traders into group 2 or 3 who otherwise would have been in group 1 (very early exercise) so the bias is against the hypothesis.

In summary, the results of the tests of the information hypotheses provide strong evidence that very early exercise decisions are followed by inferior stock price performance when compared with stock price performance following exercise decisions around the risk-neutral exercise point. This supports the general hypothesis that very early exercise of ESOs may be partially attributed to trading on negative private information.

---

[3]. Some executives routinely sell enough shares to pay the income taxes on the gain realized by exercising. Exercise decisions where executives simply sold enough shares to cover their income tax liability would not be included in the 175 exercise decisions where executives sold more than half of the acquired shares.

The final step in the research design is to revisit hypothesis 1 (that the mean value of τ is less than one) for exercise decisions that are followed by non-negative price changes. The purpose of this sample restriction is to try and separate the effects of information trading from the effects of risk and liquidity preference. Exercise decisions that are followed by non-negative price changes are less likely to be information trades. Of the 315 exercise decisions where the date of the exercise could be observed in the *Official Summary of Security Transactions and Holdings*, 132 were followed by non-negative price changes.[4] The distribution of τ for these exercise decisions is presented in figure 5-1. The mean level of τ for this restricted sample is 0.963 which is not significantly different from 1. Also, the percentage of exercise decisions where the level of τ is less than 0.6 is 13% (compared with 17% for the full sample). The percentage of exercise decisions where the level of τ is less than 0.8 is 29% (compared with 37% for the full sample).

---

[4] The fact that only 132 out of 315 exercise decisions were followed by non-negative stock price performance is consistent with the idea that managers use private information when making exercise decisions.

When the sample is restricted to exercise decisions that are followed by non-negative stock price changes, the hypothesis that the mean level of τ is significantly less than one is not supported. The distribution around one is also tighter than for the full sample of all exercise decisions. These results are consistent with the notion that exercise decisions that occur before the risk-neutral exercise point are influenced by private information.

TABLE 5-1, Panel A: Proportion of exercise decisions that are followed by price declines during the period after exercise. Exercise decisions are grouped according to the exercise timing parameter τ.

	$\tau < 0.6$	$0.6 \leq \tau \leq 1.4$	$\tau > 1.4$
3 months after exercise	32/55 58%	121/229 53%	18/31 58%
6 months after exercise	38/55* 69%	126/229 55%	19/31 61%
12 months after exercise	34/55 62%	111/229 48%	11/31 35%
18 months after exercise	37/55* 67%	103/229 45%	16/31 52%

* denotes a significant difference between the proportion of price declines in the group designated and the middle group at the 97.5% confidence level (one-tailed test).

Panel B: Mean stock price change between the date of exercise and dates subsequent to exercise.

	$\tau < 0.6$ (n=55)	$0.6 \leq \tau \leq 1.4$ (n=229)	$\tau > 1.4$ (n=31)
3 months after exercise	-0.91%	+0.67%	-1.53%
6 months after exercise	-5.57%*	+1.78%	-2.34%
12 months after exercise	-6.03%*	+8.34%	+3.99%
18 months after exercise	-3.83%*	+10.98%	-0.84%*

* denotes a significant difference between the mean stock price change of the designated group and the mean stock price change of the middle group at the 97.5% confidence level (one-tailed t-test of the difference in means).

TABLE 5-2, Panel A: Proportion of exercise decisions that are followed by price declines during the period after exercise. Exercise decisions are grouped according to the exercise timing parameter τ.

	$\tau < 0.7$	$0.7 \leq \tau \leq 1.3$	$\tau > 1.3$
3 months after exercise	48/82 59%	94/188 50%	29/45 64%
6 months after exercise	55/82* 67%	101/188 54%	27/45 60%
12 months after exercise	49/82* 60%	86/188 46%	21/45 47%
18 months after exercise	52/82* 63%	79/188 42%	25/45 56%

* denotes a significant difference between the proportion of price declines in the group designated and the middle group at the 97.5% confidence level (one-tailed test).

Panel B: Mean stock price change between the date of exercise and dates subsequent to exercise.

	$\tau < 0.7$ (n=82)	$0.7 \leq \tau \leq 1.3$ (n=188)	$\tau > 1.3$ (n=45)
3 months after exercise	-0.48%	+1.09%	-2.4%*
6 months after exercise	-0.48%	+1.09%	-2.83%*
12 months after exercise	-0.97%*	+9.25%	+0.97%*
18 months after exercise	-0.36%*	+12.71%	-1.84%*

* denotes a significant difference between the mean stock price change of the designated group and the mean stock price change of the middle group at the 97.5% confidence level (one-tailed t-test of the difference in means).

TABLE 5-3, Panel A: Proportion of exercise decisions that are followed by price declines during the period after exercise. Exercise decisions are grouped according to the exercise timing parameter τ.

	$\tau < 0.8$	$0.8 \leq \tau \leq 1.2$	$\tau > 1.2$
3 months after exercise	64/111 58%	71/147 48%	36/57* 63%
6 months after exercise	73/111* 66%	76/147 52%	34/57 60%
12 months after exercise	61/111* 55%	66/147 45%	29/57 51%
18 months after exercise	66/111* 59%	56/147 38%	34/57 60%

* denotes a significant difference between the proportion of price declines in the group designated and the middle group at the 97.5% confidence level (one-tailed test).

Panel B: Mean stock price change between the date of exercise and dates subsequent to exercise.

	$\tau < 0.8$ (n=111)	$0.8 \leq \tau \leq 1.2$ (n=147)	$\tau > 1.2$ (n=57)
3 months after exercise	-0.27%	+1.84%	-1.75%
6 months after exercise	-1.08%	+1.84%	-2.14%
12 months after exercise	+0.97%*	+10.66%	+0.48%*
18 months after exercise	+2.32%*	+14.78%	-2.69%*

* denotes a significant difference between the mean stock price change of the designated group and the mean stock price change of the middle group at the 97.5% confidence level (one-tailed t-test of the difference in means).

TABLE 5-4, Panel A: Proportion of exercise decisions that are followed by price declines during the period after exercise. Exercise decisions are grouped according to the exercise timing parameter τ.

	$\tau < 0.5$	$0.5 \leq \tau \leq 1.5$	$\tau > 1.5$
3 months after exercise	17/25 68%	141/266 53%	14/24 58%
6 months after exercise	19/25* 76%	150/266 56%	14/24 58%
12 months after exercise	14/25 56%	135/266 51%	7/24 29%
18 months after exercise	17/25* 68%	126/266 47%	13/24 54%

* denotes a significant difference between the proportion of price declines in the group designated and the middle group at the 97.5% confidence level (one-tailed test).

Panel B: Mean stock price change between the date of exercise and dates subsequent to exercise.

	$\tau < 0.5$ (n=25)	$0.5 \leq \tau \leq 1.5$ (n=266)	$\tau > 1.5$ (n=24)
3 months after exercise	-4.9%	+0.77%	-1.08%
6 months after exercise	-7.49%*	+1.02%	-2.33%
12 months after exercise	-5.9%*	+6.4%	+5.71%
18 months after exercise	-7.42%*	+9.52%	-2.98%*

* denotes a significant difference between the mean stock price change of the designated group and the mean stock price change of the middle group at the 97.5% confidence level (one-tailed t-test of the difference in means).

+
TABLE 5-5, Panel A: Proportion of exercise decisions that are followed by price declines during the period after exercise. Exercise decisions are grouped according to the exercise timing parameter τ. The sample includes only those exercise decisions that are accompanied by immediate sales of more than 50% of the acquired shares.

	$\tau < 0.6$	$0.6 \leq \tau \leq 1.4$	$\tau > 1.4$
3 months after exercise	18/32 56%	58/120 48%	14/23* 61%
6 months after exercise	22/32* 69%	58/120 48%	15/23* 65%
12 months after exercise	22/32* 69%	55/120 46%	8/23 35%
18 months after exercise	22/32* 69%	46/120 38%	12/23* 52%

* denotes a significant difference between the proportion of price declines in the group designated and the middle group at the 97.5% confidence level (one-tailed test).

Panel B: Mean stock price change between the date of exercise and dates subsequent to exercise.

	$\tau < 0.6$ (n=32)	$0.6 \leq \tau \leq 1.4$ (n=120)	$\tau > 1.4$ (n=23)
3 months after exercise	-3.30%*	+2.91%	-2.18%*
6 months after exercise	-8.61*	+5.57%	-2.63%*
12 months after exercise	-12.05%*	+15.65%	+4.85%*
18 months after exercise	-7.32%*	+20.14%	-0.90%*

* denotes a significant difference between the mean stock price change of the designated group and the mean stock price change of the middle group at the 97.5% confidence level (one-tailed t-test of the difference in means).

TABLE 5-6, Panel A: Proportion of exercise decisions that are followed by price declines during the period after exercise. Exercise decisions are grouped according to the exercise timing parameter τ. The sample includes only those exercise decisions that are accompanied by immediate sales of more than 50% of the acquired shares.

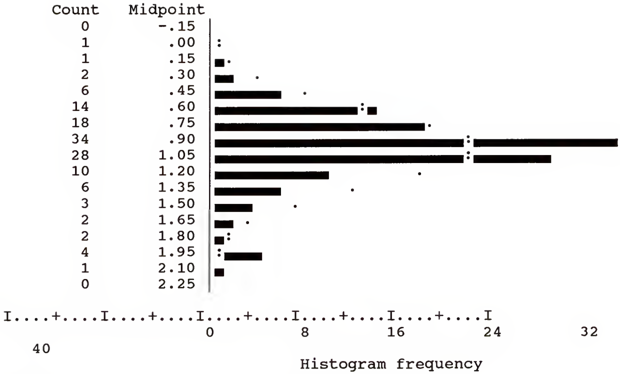
	$\tau < 0.8$	$0.8 \leq \tau \leq 1.2$	$\tau > 1.2$
3 months after exercise	37/67* 55%	31/75 41%	22/33* 67%
6 months after exercise	44/67* 66%	30/75 40%	21/33* 64%
12 months after exercise	40/67* 60%	30/75 40%	15/33 45%
18 months after exercise	40/67* 60%	21/75 28%	19/33* 57%

* denotes a significant difference between the proportion of price declines in the group designated and the middle group at the 97.5% confidence level (one-tailed test).

Panel B: Mean stock price change between the date of exercise and dates subsequent to exercise.

	$\tau < 0.8$ (n=67)	$0.8 \leq \tau \leq 1.2$ (n=75)	$\tau > 1.2$ (n=33)
3 months after exercise	-0.80%*	+4.34%	-2.33%*
6 months after exercise	-0.85%	+6.37%	-2.72%*
12 months after exercise	+0.10%*	+20.37%	+2.09%*
18 months after exercise	+2.19%*	+27.95%	-2.49%*

* denotes a significant difference between the mean stock price change of the designated group and the mean stock price change of the middle group at the 97.5% confidence level (one-tailed t-test of the difference in means).



Median = 0.923, mean = 0.963, std err = 0.031.

FIGURE 5-1: Frequency distribution and histogram (normal distribution superimposed) of τ when the estimation of the binomial is made using implied volatility. The sample is restricted to exercise decisions followed by non-negative price movements (during the first 6 months). Compare to figure 4-1 (implied volatility).

CHAPTER 6
IMPLICATIONS AND AVENUES FOR FUTURE RESEARCH

Huddart (1994) demonstrated that Black-Scholes estimates overstate the fair value of employee stock options if employees adopt very risk-averse exercise policies. Such policies cause employees to exercise at much lower stock prices than a market trader would typically exercise at. This makes the expected length of time between the issue and exercise of ESOs smaller. The firm (the short position) benefits because employees (the long position) pay the exercise price earlier than a market trader would.

The empirical evidence presented in this study provides information about the timing of exercise decisions. For the exercise decisions in the sample, the mean level of the exercise timing parameter (τ) is only slightly different from one (the risk-neutral exercise point). However, a reasonably large portion of exercise decisions were made when τ was small. This lends some support to the argument that exercise decisions are influenced by risk and other liquidity concerns.

A closer look at these exercise decisions provides evidence that the timing of exercise is also influenced by private information possessed by the managers. The effect of information trading on the fair value of ESOs is not clear.

If the firm buys shares that a manager sells because the stock price is too high, the firm loses by paying too much for the shares.[1] If, on the other hand, the manager exercises and then sells the shares to a third party, the third party loses by paying too much.

A reasonably large portion of exercise decisions were made when τ is greater than one. Exercise when τ exceeds one can only happen on dividend paying stocks. Employees who exercise after the optimal risk-neutral exercise point on dividend-paying stocks forego a dividend benefit they could have obtained by exercising at the optimal point. The firm is made better off because the employees hold the options past the optimal point and don't collect the dividends.

It appears that managers' exercise decisions are influenced by a variety of factors including risk or liquidity concerns, signalling concerns, and private information. The evidence that managers use private information when making exercise decisions supports the market practice of watching insider trades for information. The results of this study suggest that the information provided by insider exercise and sell decisions depends on the timing of exercise relative to the risk-neutral exercise point.

---

[1]. This would be the case with stock appreciation rights where the firm pays the manager a cash amount equal to the difference between the exercise price and the market price of the stock at the exercise date.

The Black-Scholes pricing model may be interpreted as a risk-neutral and information-neutral method of valuing employee stock options. Finance research indicates that the Black-Scholes value should be adjusted for expected dividend payments and the effect that these payments have on the expected life of the option. Although the binomial model is better suited to making dividend adjustments, the Black-Scholes model works reasonably well.

Based on the results of the present study, further adjustment to the Black-Scholes value for risk averse exercise behavior may not be necessary for many managers of large companies. Most managers appear to exercise around the risk-neutral exercise point. Some managers appear to exercise before and after the risk-neutral point for a variety of reasons. Whether these managers behave in a predictable manner from one exercise decision to another is an open question not addressed in this study.

The results of this study do not necessarily extend to employees at other levels of large companies and managers of smaller companies. Employees at lower levels do not have to worry as much about how their exercise decisions will be interpreted. Their exercise decisions are not monitored as closely by regulators and investors. Employees at lower levels may be more risk-averse and more susceptible to other liquidity concerns since they are not as wealthy as top managers. Also, employees at lower levels will generally not have the access to private information that top executives have. Managers at smaller companies may also have different risk and liquidity concerns from managers at large companies.

An important avenue for future research is the investigation of exercise policies of employees at various levels within the organization.[2] The FASB statement 123 encourages companies to identify groups of employees who may have different exercise policies when estimating the expected life of ESOs. This type of research would require access to data on more employees.

A second important avenue for future research is the expansion of tests of the information hypotheses. An immediate concern is external validation of the tests of the information hypotheses. Proper validation of these tests would require construction of another data set. To provide some information with respect to external validity, I split the data set into three subsets of equal size. The split was made arbitrarily at the firm level (each subset contains employees from about 20 firms). Tests of the information hypotheses were repeated for these subsets and are included as table 6-1 (where the very early exercise group includes levels of τ less than 0.6) and table 6-2 (where the very early exercise group includes levels of τ less than 0.8).

---

[2] I compared the level of τ for CEOs and non-CEOs in my sample on a company by company basis. Specifically I determined the average level of τ for a CEO's exercise decisions in a specific year and the average level of τ for non-CEO managers with the same company in the same year. In 60% of the cases, the average level of τ was higher for the CEO. The proportion of cases in which the CEO's τ was higher is not statistically significant.

Since each of the three subsets includes only 105 exercise decisions, the results are not statistically clear. Table 6-1, panel A provides information about the pattern of price declines after exercise. Sets 1 and 3 provide a similar pattern to that found for the compete data set (price declines appear more frequently after very early and late exercise decisions), set 2 does not provide the same pattern. Table 6-1, panel B provides information about the mean price changes after exercise. Here, the pattern for all three sets is similar to that found for the complete data set (price changes are smaller for very early and late exercise decisions).

When the very early exercise set is defined by τ less than 0.8 (see table 6-2), the pattern of price declines is similar to the full data set for sets 1 and 3. The pattern of mean price changes is similar to the full data set for sets 2 and 3.

These tables reenforce the need for external validation through construction and testing of another data set. Future testing may consider a wider spectrum of companies, particularly emerging companies. Emerging companies make extensive use of ESOs. Since fewer analysts follow these companies, more information may be conveyed through exercise decisions made by insiders of these companies.

TABLE 6-1, Panel A: Proportion of exercise decisions that are followed by price declines during the period after exercise. Exercise decisions are grouped according to the exercise timing parameter τ. The sample of 315 exercise decisions is arbitrarily split into three sets of 105 decisions per set.

SET 1	$\tau < 0.6$	$0.6 \le \tau \le 1.4$	$\tau > 1.4$
3 months after exercise	14/21 67%	37/79 47%	3/5 60%
6 months after exercise	17/21 81%*	42/79 53%	4/5 80%*
12 months after exercise	16/21 76%	46/79 58%	4/5 80%
18 months after exercise	17/21 81%*	39/79 49%	4/5 80%*

SET 2	$\tau < 0.6$	$0.6 \le \tau \le 1.4$	$\tau > 1.4$
3 months after exercise	9/19 47%	36/65 55%	12/21 57%
6 months after exercise	8/19 42%	33/65 51%	14/21 67%
12 months after exercise	10/19 53%	31/65 48%	6/21 29%
18 months after exercise	7/19 37%	23/65 35%	10/21 48%

SET 3	$\tau < 0.6$	$0.6 \le \tau \le 1.4$	$\tau > 1.4$
3 months after exercise	9/15 60%	48/85 56%	3/5 60%
6 months after exercise	13/15 87%*	51/85 60%	1/5 20%
12 months after exercise	8/15 53%	31/65 40%	1/5 20%
18 months after exercise	13/15 87%*	41/85 48%	2/5 40%

* denotes a significant difference between the proportion of price declines in the group designated and the middle group ($0.6 \le \tau \le 1.4$) at the 97.5% confidence level (one-tailed test).

TABLE 6-1 - continued, Panel B: Mean stock price change between the date of exercise and dates subsequent to exercise. The sample of 315 exercise decisions is arbitrarily split into three sets of 105 decisions per set.

SET 1	$\tau < 0.6$ (n=21)	$0.6 \leq \tau \leq 1.4$ (n=85)	$\tau > 1.4$ (n=5)
3 months after exercise	-2.87%	+1.15%	-8.38%
6 months after exercise	-9.16%	-1.13%	-10.51%
12 months after exercise	-11.08%*	+3.07%	-8.38%
18 months after exercise	-2.30%	+9.40%	-11.65%*

SET 2	$\tau < 0.6$ (n=19)	$0.6 \leq \tau \leq 1.4$ (n=65)	$\tau > 1.4$ (n=21)
3 months after exercise	+3.95%	-0.29%	-0.38%
6 months after exercise	+1.59%	+3.07%	-8.38%
12 months after exercise	+1.29%	+6.88%	+4.85%
18 months after exercise	-0.05%	+9.90%	+1.03%

SET 3	$\tau < 0.6$ (n=19)	$0.6 \leq \tau \leq 1.4$ (n=85)	$\tau > 1.4$ (n=5)
3 months after exercise	-4.32%	+3.07%	+0.59%
6 months after exercise	-9.61%*	+3.50%	+3.92%
12 months after exercise	-8.24%*	+14.07%	+12.47%
18 months after exercise	-10.77%*	+12.46%	+2.12%

* denotes a significant difference between the mean stock price change of the designated group and the mean stock price change of the middle group ($0.6 \leq \tau \leq 1.4$) at the 97.5% confidence level (one-tailed t-test of the difference in means).

TABLE 6-2, Panel A: Proportion of exercise decisions that are followed by price declines during the period after exercise. Exercise decisions are grouped according to the exercise timing parameter τ. The sample of 315 exercise decisions is arbitrarily split into three sets of 105 decisions per set.

SET 1	$\tau < 0.8$	$0.8 \leq \tau \leq 1.2$	$\tau > 1.2$
3 months after exercise	21/32 66%*	26/60 43%	7/13 54%
6 months after exercise	25/32 78%*	29/60 48%	9/13 69%
12 months after exercise	23/32 72%	33/60 55%	10/13 77%
18 months after exercise	23/32 72%*	27/60 45%	10/13 77%*

SET 2	$\tau < 0.8$	$0.8 \leq \tau \leq 1.2$	$\tau > 1.2$
3 months after exercise	23/44 52%	18/33 55%	16/28 57%
6 months after exercise	20/44 45%	17/33 52%	18/28 64%
12 months after exercise	22/44 50%	15/33 45%	10/28 36%
18 months after exercise	17/44 39%	9/33 27%	14/28 50%

SET 3	$\tau < 0.8$	$0.8 \leq \tau \leq 1.2$	$\tau > 1.2$
3 months after exercise	20/35 57%	27/54 50%	13/16 81%*
6 months after exercise	28/35 80%*	30/54 56%	7/16 44%
12 months after exercise	16/35 46%	18/54 33%	9/16 56%
18 months after exercise	26/35 74%*	20/54 37%	10/16 63%

* denotes a significant difference between the proportion of price declines in the group designated and the middle group ($0.8 \leq \tau \leq 1.2$) at the 97.5% confidence level (one-tailed test).

TABLE 6-2 - continued, Panel B: Mean stock price change between the date of exercise and dates subsequent to exercise. The sample of 315 exercise decisions is arbitrarily split into three sets of 105 decisions per set.

SET 1	$\tau < 0.8$ (n=32)	$0.8 \leq \tau \leq 1.2$ (n=60)	$\tau > 1.2$ (n=13)
3 months after exercise	-1.74%	+1.45%	-4.04%
6 months after exercise	-5.32%	-1.86%	-4.04%
12 months after exercise	-1.29%	+1.57%	-4.54%
18 months after exercise	+8.94%	+7.66%	-8.41%*

SET 2	$\tau < 0.8$ (n=44)	$0.8 \leq \tau \leq 1.2$ (n=33)	$\tau > 1.2$ (n=28)
3 months after exercise	-1.29%	-0.11%	-1.11%
6 months after exercise	+2.35%	+3.32%	-2.37%
12 months after exercise	+2.92%	+10.99%	+2.96%
18 months after exercise	+1.64%	+17.49%	+0.52%

SET 3	$\tau < 0.8$ (n=35)	$0.8 \leq \tau \leq 1.2$ (n=54)	$\tau > 1.2$ (n=16)
3 months after exercise	-1.68%	+1.90%	-1.62%
6 months after exercise	-2.76%	-0.11%	-0.18%
12 months after exercise	+0.60%*	+20.56%	+0.23%*
18 months after exercise	-3.69%*	+21.04%	-6.20%*

* denotes a significant difference between the mean stock price change of the designated group and the mean stock price change of the middle group ($0.8 \leq \tau \leq 1.2$) at the 97.5% confidence level (one-tailed t-test of the difference in means).

REFERENCES

Beckers, S. "Standard Deviations in Option Prices as Predictors of Future Stock Price Variability." *Journal of Banking and Finance* (September 1981): 363-82.

Black, F., "Fact and Fantasy in the Use of Options and Corporate Liabilities." *Financial Analysts Journal* (July-August 1975): 36-41, 61-72.

Black, F. "Studies of Stock Price Volatility Changes." Proceedings of the meetings of the American Statistical Association, Business and Economics Statistics Section, Chicago, 1976.

Black, F., and M. Scholes. "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy* (May/June 1973): 637-59.

Blattberg, R., and N. Gonedes. "A Comparison of the Stable and Student Distributions as Statistical Models for Stock Prices." *Journal of Business* (April 1974): 244-80.

Boudreaux, K., and S. Zeff. "A Note on the Measure of Compensation Implicit in Employee Stock Options." *Journal of Accounting Research* (Spring 1976): 158-62.

Buenaventura, M., and C. Peck. *Stock Options: Motivating Through Ownership*. New York: The Conference Board, 1993.

Cox, J.C., and S.A. Ross. "The Valuation of Options for Alternative Stochastic Processes." *Journal of Financial Economics* (1976): 145-66.

Cox, J., S. Ross, and M. Rubinstein. "Option Pricing: A Simplified Approach." *Journal of Financial Economics* (September 1979): 229-63.

FASB 1995. *Statement of Financial Accounting Standards No. 123. Accounting for Stock Based Compensation* (October 1995).

Foster III, T., P. Koogler, and D. Vickrey. "Valuation of Executive Stock Options and the FASB Proposal." *The Accounting Review* (July 1991): 595-610.

Galai, D. "A Note on Equilibrium Warrant Pricing Models and Accounting for Executive Stock Options." *Journal of Accounting Research* (Autumn 1989): 313-15.

Gibbons, R., and K. Murphy. "Optimal Incentive Contracts in the Presence of Career Concerns: Theory and Evidence." *Journal of Political Economy* (1992): 468-505.

Hirschey, M., and J. Zaima. "Insider Trading, Ownership Structure and the Market Assessment of Corporate Sell-Offs." *The Journal of Finance* 44 (1989): 971-80.

Holmström, B. "Moral Hazard and Observability." *Bell Journal of Economics* (Spring 1979): 74-91.

Huddart, S. "Employee Stock Options." *Journal of Accounting and Economics* (September 1994): 207-31.

Hull J. *Options, Futures, and other Derivative Securities.* Englewood Cliffs, NJ: Prentice-Hall, 1993.

Jarrow, R., and A. Rudd. *Option Pricing*. Homewood, Ill: Dow-Jones Irwin, 1983.

Jennergren, L., and B. Näslund. A Comment on "Valuation of Executive Stock Options and the FASB Proposal." *The Accounting Review* (January 1993): 179-83.

John, K., and L. Lang. "Insider Trading around Dividend Announcements: Theory and Evidence." *The Journal of Finance* (September 1991): 1361-89.

John, K., and B. Mishra. "Information Content of Insider Trading Around Corporate Announcements: The Case of Capital Expenditures." *The Journal of Finance* (July 1990): 835-55.

Lambert, R., D. Larcker and R. Verrecchia. "Portfolio Considerations in Valuing Executive Compensation." *Journal of Accounting Research* (Spring 1991): 129-49.

Leland, H. "Insider Trading: Should it be Prohibited?" *Journal of Political Economy* (August 1992): 859-88.

Lewellen, W., C. Loderer, and K. Martin. "Executive compensation and executive incentive problems." *Journal of Accounting and Economics* (December 1987): 287-310.

Lintner, J. "Security Prices, Risk and Maximal Gains from Diversification." *Journal of Finance* (December 1965): 13-37.

MacBeth J., and L. Merville. "An Empirical Examination of the Black-Scholes Call Option Pricing Model." *Journal of Finance* (December 1979): 1173-86.

MacBeth J., and L. Merville. "Tests of the Black-Scholes and Cox Call Option Valuation Models." *Journal of Finance* (May 1990): 285-301.

Merton, R. "Theory of Rational Option Pricing." *Bell Journal of Economics and Management Science* (Spring 1973): 141-83.

Noreen, E., and M. Wolfson. "Equilibrium Warrant Pricing Models and Accounting for Executive Stock Options." *Journal of Accounting Research* (Autumn 1981): 384-98.

Robbins, B. "FASB's Long Look at Stock Compensation Plans." *Journal of Accountancy* (August 1988): 60-68.

Sharpe, W. "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk." *Journal of Finance* (September 1964): 425-42.

Smith, C., and J. Zimmerman. "Valuing Employee Stock Option Plans using Option Pricing Models." *Journal of Accounting Research* (Autumn 1976): 357-64.

Weygandt, J. "Valuation of Stock Option Contracts." *The Accounting Review* (January 1977): 40-51.

Whaley, R. "Valuation of American Call Options on Dividend Paying Stocks: Empirical Tests." *Journal of Financial Economics* (March 1982): 29-58.

BIOGRAPHICAL SKETCH

Mark Clifford Anderson, born on November 25, 1957, in Medicine Hat, Alberta, Canada, is a Ph.D. candidate at the Fisher School of Accounting of the College of Business Administration at the University of Florida.

Mark received a Bachelor of Arts degree with distinction at the University of Alberta in 1978. In 1981 he received a Masters of Business Administration degree from the University of Alberta. He received a Master of Science degree in accounting at the University of Rochester in 1990.

Mark was admitted as a member of the Society of Management Accountants of Alberta in 1986 and as a member of the Institute of Chartered Accountants of Alberta in 1987.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

A.R. Abdel Khalik

A. Rashad Abdel-khalik, Chairman
Graduate Research Professor of Accounting

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Bipin B. Ajinkya
Professor of Accounting

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Michael D. Ryngaert
Associate Professor of Finance, Insurance, and Real Estate

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

A.S. Ahmed

Anwer S. Ahmed
Assistant Professor of Accounting

This dissertation was submitted to the Graduate Faculty of the Fisher School of Accounting in the College of Business Administration and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

May, 1996

Dean, Graduate School